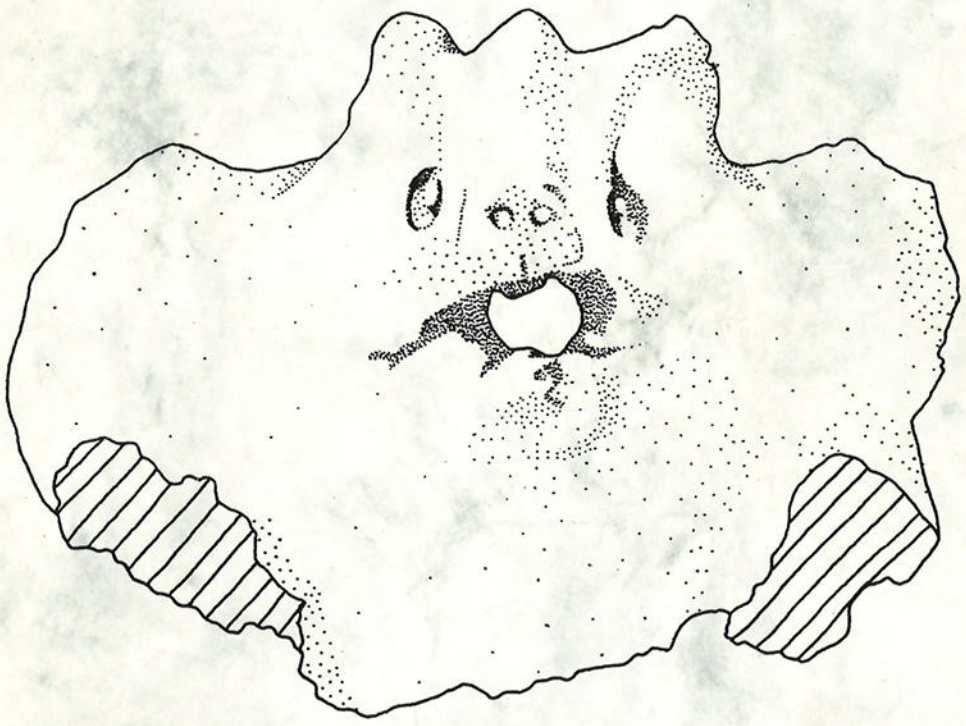
THE PETITE RIVIERE EXCAVATIONS
LA DESIRADE, FRENCH WEST INDIES

Fieldwork report and subsistence studies for a pre-Columbian site with Late Saladoid and post-Saladoid components



Maaike Sibilla de Waal

Thesis for the title Master of Arts in "Archaeology and Culture History of the Americas" and "Pre- and Protohistory" at the University of Leiden, The Netherlands. 20 september 1996

THE PETITE RIVIERE EXCAVATIONS
LA DESIRADE, FRENCH WEST INDIES

ERRATUM

The catchment circles, that are represented in the autocad drawings in paragraph 5.2.2., 'Site catchment at the Petite Rivière site', should be considered as having 5 km diameters, instead of 5 km radii. As a result of this, the 5 km ranges that are mentioned in the text should be considered as 2.5 km ranges.

Maaike de Waal,
Leiden, September 1996

THE PETITE RIVIERE EXCAVATIONS
LA DESIRADE, FRENCH WEST INDIES

Fieldwork report and subsistence studies for a pre-Columbian site with Late Saladoid and post-Saladoid components

Maaike Sibilla de Waal

Thesis for the title Master of Arts in "Archaeology and Culture History of the Americas" and "Pre- and Protohistory" at the University of Leiden, The Netherlands. 20 september 1996

Voor Anke

ACKNOWLEDGEMENTS

The present study is a report on fieldwork that was executed in 1984 and 1995 at the pre-Columbian site of Petite Rivière at the island of La Désirade, Guadeloupe, French West Indies. It describes these fieldwork campaigns and the archaeological material which was obtained. In addition, an attempt is made to provide an insight in the subsistence system of the pre-Columbian inhabitants of the site.

The project was supported by a financial contribution by the 'Letterenfonds' of Leiden University. It took place under the auspices of Prof. Dr. L.P. Louwe Kooijmans (Department of Pre- and Protohistory, Leiden University), Dr. C.L. Hofman and Drs. M.L.P. Hoogland (Department of Archaeology, Leiden University). The 1995 fieldwork was executed for the 'Direction Régionale des Affaires Culturelles' of Guadeloupe. Mr. A. Delpuech, 'Conservateur Régional de l'Archéologie du Département de La Guadeloupe', provided the excavation permissions, and I would also like to thank mr. Robin, mayor of La Désirade, and mr. Lallanne, owner of the Petite Rivière terrain, for their approval of the project.

I am very grateful that Simone Bloo, Alex Brokke, Stefanie Coenen, Renzo Duin, Sandrine Grouard, Tom Hamburg, Corinne Hofman, Menno Hoogland, Michiel Kappers, Claudia Kraan, Baafke Meijer and Hélène Schmitt offered to participate in the 1995 survey and test-excavations. They have been a great help, and a very nice and supporting company in the field. I also would like to thank Jolande and Sylvain Vragar and Xavier Rousseau for their hospitality on Guadeloupe.

Furthermore, I am very grateful to Steffen Baetsen for his enormous help in the identification of human skeletal remains, mr. P. Bodu for sending me all the information he could remember of his 1984 fieldwork at the site and permitting me to use it, Sandrine Grouard for the analyses of the faunal remains, Wim Kuiper (Ecological Laboratory, Leiden University) for permitting me to use sieves and a microscope, and Claire Le Poole-Burnand for the dental analysis of burial 1b.

Martijn van den Bel, Marc Dorst, and Monique Ruig helped me to make the pencil drawings of the pottery. The autocad drawings represented in figures 4 and 15 were made by Michiel Kappers. I would also like to thank Edwin Smit for all his advices concerning computer applications, Peter Heavens for his corrections of the original English text, Harry de Waal for his corrections of the original French summary, and Steffen Baetsen, Martijn van den Bel, Mark Nokkert, Sebastiaan Knippenberg, and Harry de Waal for reading the text over and over.

Most of all, I would like to thank my parents Harry and Juul, my sister Anke, and Steffen for experiencing all the ups and downs with me, and for all their love, help and support.

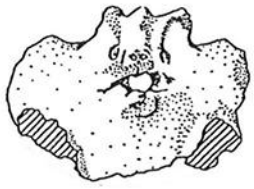
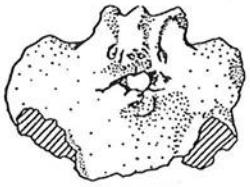
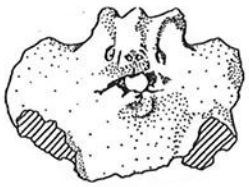


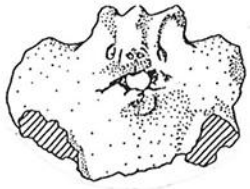
TABLE OF CONTENTS



LIST OF FIGURES



LIST OF TABLES



1 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

1.1.1 Environmental archaeology

From the first studies in the early 1930's onwards, Caribbean archaeology has been mainly focused on the establishment of a cultural-chronological framework for the region. Small-scale test excavations were carried out and an emphasis was put on the study of pottery. Recently, there tends to be a development towards systematic surveys at site and regional level (e.g. Drewett 1991) and also larger-scale excavations in order to get an insight into settlement structures, patterns and systems (e.g. Siegel 1992; Versteeg and Schinkel 1992). Studies of all artefact categories are carried out in order to provide a better behavioural understanding of the past.

To come to such behavioural understanding, it is important to understand the relationships between pre-Columbian societies and their environment. Humans interact with the systems and subsystems that surround them. This thought has been visualized by Clarke (1968) in what he called the 'environmental subsystem'. It describes the interrelationships between the many branches of ecology which comprise the human environment, and human social, economic, religious, and material culture subsystems (fig. 1). Environmental archaeology is based on the thought that the environment governs human life.

In the point of view of environmental archaeology the environment determined how and where humans lived in the past. Environmental archaeology studies sites within their geomorphological and biological setting, and information is obtained on what the paleo-environment and the paleo-climate might have been like in the period of interest, and on what might have been their influences on the possible loss of sites through erosion or inundation. Environmental archaeology may yield information on, for example, vegetation cover, climate, soil conditions, fauna, seasons in which sites were occupied, past human diet, the quantity of land available in the past, and land-use potential through analysis of plant remains, faunal remains, sea cores and ancient coast lines, composition and texture of sediments and soils, and on methods for examining the human exploitation of the environment (Renfrew and Bahn 1991:195-226).

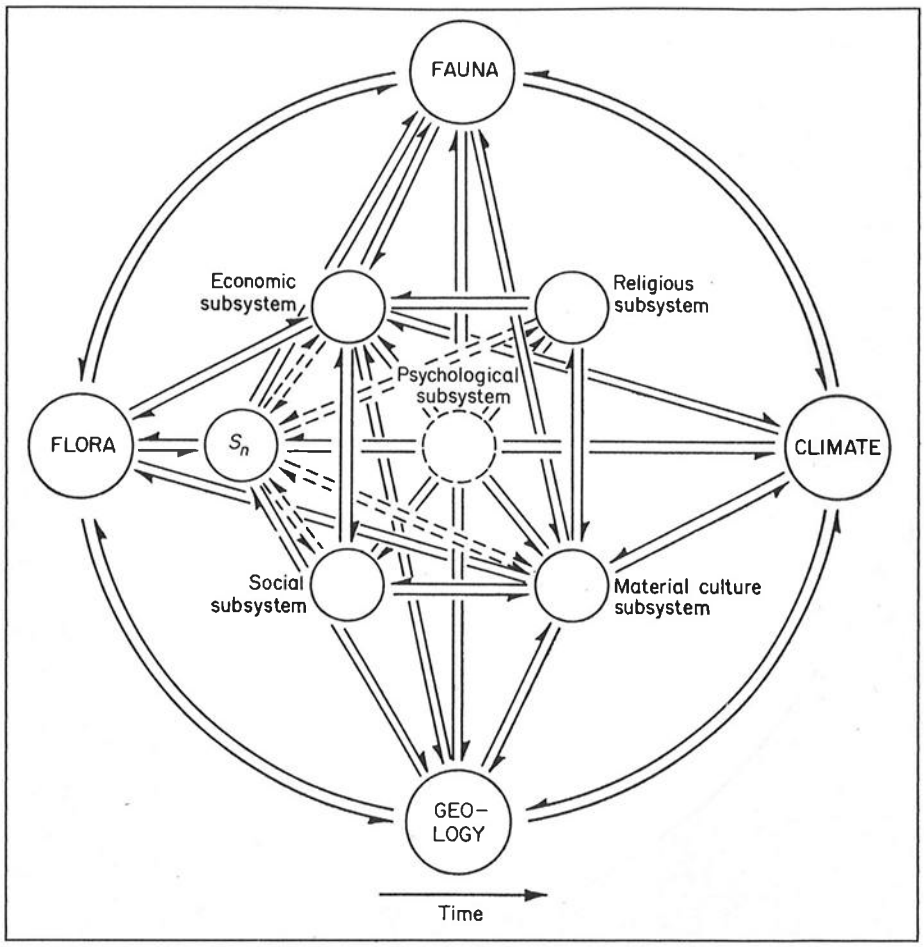


Figure 1. A static and schematic model of the dynamic equilibrium between the subsystem networks of single Sociocultural System and its total Environment System (After Clarke 1968:fig.17)

1.1.2 Subsistence

The location of a site and the environment in which it is situated greatly influence the subsistence, or the 'quest for food' of its inhabitants. The study of subsistence in the past is a branch of environmental archaeology. Subsistence-systems can be defined as

> "complex interactions between cultural concepts of what organisms are edible, technological repertoire of food procurement and preparation, and the potentials of the environment" (Wing and Brown 1979:1), or as "[systems that] indicate the satisfaction of the human body's physiological requirements through the procurement of food sources" (Keegan 1982[a]:148).

According to Keegan (1982[a]), subsistence can be expressed as the sum of the contributing procurement strategies. He defined subsistence as D=GP+DP+MC+H+F. In this definition

D is for diet[1], GP for gathered plants, DP for domesticated plants, MC for mollusc collecting, H for hunting , and F for fishing.

In archaeology, the reconstruction of pre-Columbian diet is based on waste products of food preparation, i.e. durable or inedible remains of animals and plants, on human skeletal remains, and on artefacts related to food procurement or preparation found in archaeological sites. These remains are unevenly represented, as a result of differences in preservation, site formation processes, and post-depositional processes (Wing and Brown 1979:5-6). Furthermore, care should also be taken with organic materials in archaeological context that are not directly associated with human activity, such as seeds, roots, or pollen from vegetation growing near the site, and animals that died on it.

Archaeological subsistence studies are important in order to get a better understanding of human behaviour in the past. The procurement, preparation, and consumption of food, depending on a familiarity with the environment, are considered important in a society, as they are essential for a groups survival and its adaptations to the environment (Wing and Brown 1979:44). Subsistence systems reflect, besides technological and strategical attitudes, cultural attitudes towards food (Harris and Ross 1987:5; Stokes 1995:193). Each social/cultural group has its own ways of obtaining, preparing, and eating food, determined for a great part by food preferences and taboos[2].

Recently, the number of subsistence studies has increased as a result of this social/cultural importance. It needs to be understood why a particular environment might have been attractive for pre-Columbian occupants, which sources could have been available there and by then, what this could have meant for subsistence and diet, and which sources can be demonstrated archaeologically to have been actually exploited. The approaches that have been developed to study pre-Columbian diet are diverse. Next to empirical approaches (e.g archaeobotanical and zooarchaeological studies, paleopathology, and stable isotope analysis), ecological, economical, and/or ethnographical models are frequently used in order to interpret the empirical categories of evidence. According to Keegan (1989[a]:223), this diversity shows the significance of subsistence activities.

---

1 Note that Keegan uses the term 'diet', which implies a short-term process, instead of 'subsistence', which is used to indicate long-term processes. In prehistoric context, most information is obatined on subsistence.

2 According to Ross (1978), food prohibitions are "a central part of human ecological adjustment, depending on the faunal productivity of the habitat, and determined by natural and cultural conditions, governing the accessible proportion of biomass".

1.2 EARLIER RESEARCH

1.2.1 Introduction

In the Americas, scientific applications of archaeological ecological approaches did not take place before the second half of the 20th century. The first important ecological studies were executed in the Americas by Steward (1955) and in Europe by Clark (1952). Both greatly influenced American ecological studies which would take place later. Steward was interested in explaining cultural change. He emphasized the fact that cultures do not only interact with one another but also with the environment. The study of ways in which adaptation to the environment could cause cultural change was called 'cultural ecology'. It stimulated the study of the economic bases of pre-Columbian societies. In Europe, Clark developed a more direct ecological approach, namely the study of how human populations had adapted to their environments by studying faunal and plant remains (Willey and Sabloff 1980:131,151).

Those early studies took linear models, in which environment influences culture, as a starting point. Later, holistic or systemic models, in which human populations are seen as parts of ecosystems, were applied. Flannery's (1976[a]) site catchment analysis is an example of this (Willey and Sabloff 1980:191). Out of these early ecological researches has grown the whole field of environmental and dietary reconstruction.

In the 1960's, but especially in the 1970's, ecologists started to determine the course of scientific archaeological research, and different theories of food-gathering behaviour were adopted.

In the Caribbean, the first subsistence studies were executed by Wing (e.g. 1968). During the 1980's and 1990's the importance and influence of environmental and subsistence studies have increased in this region.

1.2.2 Common consents of pre-Columbian subsistence in the Caribbean[3]

Subsistence studies in the Caribbean seem to have been mainly focused on the Saladoid phases of the pre-Columbian period.

The earliest Caribbean economies are thought to have been based principally on the gathering of terrestrial and marine fauna, and wild plant foods (Armstrong 1980; Rouse 1992:58). The introduction of extensive and more intensive forms of agriculture is contributed to the migration of

[3] This paragraph is mainly based on Newsom (1993).

Amazonian root-crop horticulturalists into the Lesser Antilles (Rouse 1992), which resulted from an increasing pressure on good soils for plant cultivation and aquatic resources on the South-American mainland in the first millennium BC. It is assumed that human population growth was the mechanism behind this process (Roosevelt 1980; Rouse 1986).

The first horticulturalists in the Antilles probably concentrated on root crops and animal protein from rivers and forests (Roosevelt 1980; Rouse 1986, 1989). Some scholars, e.g Goodwin (1980), Jones (1985), and Rouse (1989), explain this emphasis as an attempt of the immigrants to maintain their mainland subsistence system as much as possible. Other scholars, e.g. DeFrance (1989), Wing (1989), and Siegel (1991), are convinced that migrants in a very early stage started adding marine and other local resources to their familiar subsistence system, as evidenced, for example, by data from the Maisabel site on Puerto Rico (DeFrance 1989:61).

On the northern Lesser Antilles and on eastern Puerto Rico, a shift seems to have taken place from this early terrestrial based diet, to one emphasizing marine foods (Goodwin 1980; Jones 1985; DeFrance 1988; Haviser 1988; Keegan 1989[a]; Wing 1989). This is called the 'crab-shell dichotomy'. This dietary shift is thought to be linked with a shift in site location from interior settings near water sources and soils suited to crop cultivation, to the coasts, nearer to marine sources but more removed from the before mentioned soils (Siegel 1991). This shift has been attributed to the representation of different cultures (Rainy 1941), climatic changes (Carbone 1980), population pressure (Goodwin 1980), and a widening of the diet breath necessitated by expanding populations and changing resource abundances (Keegan 1985; Newsom 1993).

The picture that emerges for the subsistence on the Greater Antilles in later phases of the pre-Columbian period, and for pre-Columbian subsistence on the Lesser Antilles is far less complete. Recent attempts (e.g. Drewett 1989, 1991; Allaire 1991; Hoogland 1996) have been made to start the building of a database concerning pre-Columbian subsistence and a larger regional framework for this later period in the Caribbean. More studies, however, will be needed on subsistence in this later period to come to a better understanding of past human behaviour.

1.3 ENVIRONMENTAL AND SUBSISTENCE STUDIES IN THE CARIBBEAN

1.3.1 Introduction

As a result of the incomplete nature of the archaeological record, the study of pre-Columbian subsistence systems and diet requires an interdisciplinary research approach, combining archaeological, anthropological, biological and ethnohistorical information. According to Keegan

(1987) and Stokes (1995), such interdisciplinary research approach could best be divided in three phases.

In the first phase, the types of data to be collected and the techniques by which these data should be analysed must be identified and hypotheses concerning past subsistence activities must be generated. This phase should include ecological or economic models of subsistence behaviour which describe an idealized structure of subsistence decision making.

Secondly, the archaeological record must be used. In this phase, empirical data on subsistence activities are obtained. This evidence can be obtained through the study of animal (including shellfish) remains, plant remains, artefacts used for the production and processing of food, and (dental) pathology on skeletal remains. The archaeological record gives an impression of the sources that were available. Unfortunately, faunal remains tend to be overrepresented at the cost of floral remains, due to differences in preservation. Furthermore, it is not possible to determine the percentages of the foods in the diet on the basis of the archaeological record alone (Stokes 1995: 193).

Finally, a direct measurement of actual long-term consumption is required in order to obtain information on the percentages of different food types. Quantitative analyses, such as stable isotope analysis can be used. It can not be used independently for diet reconstruction, but it is a method for testing and refining data on subsistence that were already proposed by other sources of evidence.

This division has been used to expose the information on environmental and subsistence studies in the Caribbean in a structured manner. First, ecological and economic models that have been applied in Caribbean archaeology are being presented. Then, the studies of archaeological materials are exposed, and finally, the stable isotope method is explained.

1.3.2 The first predictive phase of subsistence research

The first phase in reconstructing pre-Columbian diet requires the examination of what resources were available and what resources might actually have been exploited. In general, ethnohistoric reports, ethnographic analogies, experiments, and ecological and economic models can be used to obtain information of this kind.

1.3.2.1 Ethnohistoric reports

For the Caribbean, several colonial reports exist. For the lesser Antilles, there are french reports from the seventeenth century, in which European influences may already be present. Among the best-known are the historic reports of Breton (1647), de Rochefort (1658), and du Tertre (1667).

Although being very informative in the descriptions of the use the Amerindians made of marine and terrestrial foods, it should not be forgotten that the writers of colonial documents usually tended to give a short-term view of subsistence, except for those who lived longer periods among the Amerindians, e.g. father Breton (1647). Moreover, they sometimes obscure differences in plant consumption practices between groups living on the islands and those on the mainland, and they do not provide insights in the development of the cultivation of plants and their adaptation to the insular environment (Newsom 1993:20). It must not be forgotten either that in the seventeenth century several plant and animal species had already been introduced from Europe into the Americas. However, the reports do provide information which may be essential for our understanding of locally available food sources, and Amerindian procurement strategies and food preparation methods.

1.3.2.2 Ethnographic data

A second source of evidence in the reconstruction of pre-Columbian diets are ethnographic analogies. Those analogies can provide general insights in the variety of ways people meet their subsistence needs. However, use of ethnographic models for interpretations of archaeological data has been criticized, as there will always be exceptions to widely documented, ethnographically recorded, subsistence patterns. According to Wing and Brown (1979:9), ethnographic analogy might be useful only when it comprises widely accepted cultural adaptations and human biological characteristics. Ethnographic analogies are generally imbedded in environmental, ecological and economic models and they will be treated only as such in this general overview. Unfortunately, a very detailed study of ethnohistoric reports and ethnographic data is beyond the scope of this study.

1.3.2.3 Experiments

Next to the above mentioned sources of evidence, Keegan (1982[a], 1986[b]) executed experimental research. For his analysis of pre-Columbian fishing in the Bahamas, he compared experimental fishtrap samples[4] with ecological and ethnohistorical evidence, with fishbone analysis, and with analogies of fishing in other coral waters. As Keegan (1986[b]) considers fishing to be a form of predator-prey interaction, he is convinced that behaviour of fish can be used to define human fishing behaviour.

---

4 The identification of fishtraps as primary fishing technique is archaeologically supported by the types of fish and their uniformity in size represented in many sites (Keegan 1982, 1986[b]).

1.3.2.4 Ecological and economic models

Subsistence patterns have also been studied in a more hypothetical way by applying theoretical models. One of the most commonly applied models in the Caribbean is *site catchment analysis*. This analysis is based on the assumption that the larger the distance between a resource area and a site, the less likely it will be exploited (Vita-Finzi and Higgs 1970). Site catchment analysis studies the potential productivity of the different geographical features within a 'catchment area'. The radius of such an area was estimated to be a 10 km or a two hours walk for hunter-gatherers and 5 km or a one hour walk for agricultural societies. The productivity per feature must be weighted. Land occurring within 1 km of the site was weighted as 100%, 2 km as 50%, 3 km as 33%, 4 km as 25%, and 5 km as 20% (Vita-Finzi and Higgs 1970:28). Unfortunately, estimations of soil potential and fertility in the past are hard to evaluate as environments might have changed, but according to Flannery (1976[b]:95):

> "One has two choices: he can throw up his hands in defeat, or he can reconstruct the prehistoric environment to the best of his ability and plunge ahead".

Flannery (1976[a-c]) executed inductive site catchment analyses. He did not take the potential productivity of the area as a starting point, but the resources actually found in the site. His research focused on where those resources probably came from and on the reconstruction of the size of the catchment circle. He wanted to know whether the site reflected the general character of the region, or whether it was selected for a specific natural resource. Flannery himself (1976[c]:103-116) criticized that natural resources may have changed or disappeared, that relationships between site catchment and village spacing may not be fully one to one, and that the presence of temporary camps in good foraging localities caused implications for the weighting of successive circles. If dispersed patterns for security reasons would have existed in prehistory, any weighting of zones might be subjective anyway.

In the Caribbean, catchment analyses have been executed by Haviser (1987[b], 1989, 1991) for sites on Curaçao and Bonaire, in order to distinguish Amerindian adaptive strategies. He examined and quantified geographical characteristics through the application of a point pattern analysis (see paragraph 1.4.2). This analysis was used together with the principle of least cost[5], relating to distance constraints to acquire resources, and the concept of site catchment analysis. Hoogland (1996) conducted site catchment analyses for the late pre-Columbian sites of Spring Bay and

[5] Fritz, J.M. and F. Plog, 1970, The Nature of Archaeological Explanation. In: *American Antiquity* 35:405-412.

Kelbey's Ridge on Saba. He took the resources exploited in the three different occupation periods of these sites as a starting point.

The concept of *carrying capacity* is related to the concept of site catchment analysis. Carrying capacity can be translated as the maximum size of a population which can be maintained indefinitely within an area, determined by the system of land utilization, and by geographical and ecological factors (Bose 1967; Zubrow 1975:15). Keegan et al. (1985:659-661) consider this model as a supply-demand model, providing general descriptions of human population growth in a resource-limited environment. Therefore they consider it to be suitable for a Caribbean application. A carrying capacity analysis was carried out for the island of Saba by Hoogland (1996). Hoogland (1996) used the availability of arable land as an indication for the maximum population size, largely following the method of Roosevelt (1980).

A disadvantage of this model is that problems with estimations of human population size are encountered in general. According to Jones (1985:528-531), the mean population at a time can be estimated through the calculation of the total protein consumed, as reflected in midden remains. However, these calculations are often inaccurate due to uncertainties concerning the estimation of midden size and volume, lost material, period of occupancy, and daily protein requirement.

Optimization models, which have as a starting point that calories should be maximized and work, or risk, should be minimized, have also been proposed in studies of food selection (Wing and Brown 1979:163). In the Caribbean, models of optimal foraging and cost-minimization have been used for explaining changes in pre-Columbian subsistence economies (Keegan 1989[a]:120-121). Optimal foraging theory assumes that "foraging is determined by natural selection in a way that yields the greatest possible benefit for the individual forager's survival and reproductive success" (Smith 1983:626). Thus, humans will act rationally in order to maximize the output of their actions for the least effort. To apply this theory several definitions are required. First, a limiting currency, such as protein or such as energy in the form of calories, needs to be specified. Especially the importance of protein as a limiting factor has been given much attention in explaining changes (e.g. Roosevelt 1980; Keegan 1982[a], 1985, 1987, 1989)[6]. Then, a goal, such as maximizing foraging efficiency or cost minimization, must be specified. A set of constraints, including technology, resource distributions, resource abundance, or the time factor, is specified. Finally, a set of options, i.e. the various food items that could be used to obtain the currency, should be defined.

Optimal foraging theory ranks foodtypes on the basis of their yields in protein and energy, and their costs of procurement. In theory, optimal foraging models should be able to predict the

6 Harris (1987:75) remarks that optimization currencies can not be restricted to nutritional costs and -benefits, since many edible plants and animals have non-nutritive uses.

proportional contribution of foodtypes to the optimal diet, but in archaeological practice, this preciseness is never achieved. Keegan (1986[a]:100) is convinced, however, that optimal foraging analysis can provide a structured framework for analysing and predicting subsistence change. Smith (1983:640) and Roosevelt (1987:569), on the contrary, warn for shortcomings and limiting assumptions concerning ecological, nutritional, economic, sociopolitical, demographic, technological, and symbolic dimensions of human foraging. In addition, Keegan (1992) is aware of the questionability of the assumptions on human rational behaviour, and of the accuracy of the characterization of pre-Columbian subsistence behaviour by the formulation of the optimal diet.

Keegan (1986[a]) also applied optimal foraging analysis on horticultural production. The time required to prepare the garden and to procure and process the food was considered as search time. Thus, by changing basic definitions the model might be applied as a theory of human existence behaviour.

1.3.3 Archaeological Record

The second phase in pre-Columbian dietary reconstruction research, contains the study of the materials that were found in archaeological context. These materials generally include faunal remains, waste products of shellfish gathering, plant remains (depending on depositional and post-depositional processes, the conservation on the site, the excavation objectives and methodology), human skeletal remains, and pottery, artefacts of stone or shell, that can be related to food procurement and preparation. Different disciplines are occupied with the study of these materials.

1.3.3.1 Zooarchaeology

Zooarchaeology, or archaeozoology, studies the past human use of animals. In the Caribbean, these studies have undergone an enormous increase in the last twenty years. A pioneer and the most prominent scientist working in this field is dr. Wing (1968, 1989, 1990, 1991[a], 1991[b], 1995).

The possibilities for zooarchaeological studies are greatly dependent on the preservation circumstances and the procurement methods during the excavation. Once the samples have been gathered, the analyses of the faunal remains can be applied for several kinds of research. One such research is the analysis of the animal components in pre-Columbian diets through the determination, the counting of Minimum Number of Individuals (MNI) and the relative occurrences of the species represented in the samples studied (e.g. DeFrance 1989; van der Klift 1992; Dukes and Reitz 1995; Nokkert 1995). Other studies concentrated on demographic patterns or changes (e.g. Armstrong 1980; Goodwin 1980; Jones 1985), and the reconstruction of fishing techniques (e.g. Wing 1968).

Much attention is paid to the different habitats, represented by the faunal remains in archaeological sites, and to what extent they have been exploited (e.g. Wing and Scudder 1980, 1983; Wing and Reitz 1982).

1.3.3.2 Archaeobotany

Archaeobotany, or paleoethnobotany, studies the past human use of plants. These studies do not only provide information on plants used for food, medicine, and fuelwood, but also on raw materials used for "building constructions, transportation, weapons, tools, fiber industries, and products such as gums, resins, tannins, paints, and fish poisons" (Newsom 1993). Unfortunately, only recently, since the 1980's, systematic archaeobotanical research has been undertaken in the Caribbean. Therefore, few primary data exist on the plant component of pre-Columbian economies in the Caribbean, for only preserved plant parts provide direct information on the actual species used. Plant remains are difficult to procure in excavations and preservation circumstances are often far from ideal. A first structured and comprehensive contribution to the understanding of Amerindian plant use in the Caribbean was made by Newsom (1993).

1.3.3.3 Study of artefacts

Artefacts from archaeological excavations can sometimes be associated with pre-Columbian food production and procurement strategies. Hunting activities can be evidenced artefactually through finds of spears and spear throwers (Wing and Brown 1979:99-101), and gathering in the form of baskets. Unfortunately, baskets or other perishable materials have very often not been preserved in the Caribbean. Perishable artefactual evidence of fishing, such as netting, is not found either. However, sometimes netting weights, fishing hooks, and spears and harpoons do occur in the archaeological record (Wing and Brown 1979:93-99).

Pre-Columbian agricultural activities are mostly reflected by stone, shell, or bone axes that may have been used in land clearing (Wing and Brown 1979:101-104). Further information on pre-Columbian agricultural practices is provided through finds of grinding stones, griddle fragments, and grater board teeth. The presence of grinding stones ('manos' and 'metates') is often used as evidence for maize production and consumption (e.g. Bullen 1964). Newsom (1993:21), however, states that these stones might also have been used to mill panicoid grass seeds, and that the existence of maize cultivation can only be demonstrated through the discovery of maize plant

remains. The presence of griddle fragments[7] is usually used to demonstrate manioc cultivation and consumption. Griddles were used for baking the flower which results after peeling, washing, and grating the manioc tubers on grater boards with small lithic chips (Newsom 1993). However, for Newsom (1993:22) it could be just as likely that wild indigenous roots and grains were processed into flour and baked on griddles, and according to DeBoer (1975), the possibilities should not be excluded that maize was being processed.

1.3.3.4 Study of human skeletal remains

In some cases human skeletal remains reflect nutritional diseases, which provide information on subsistence and/or diet[8]. Different methods can be applied in studying those pathologies, such as demographic analysis, radiographic analysis, visualizing metacarpal notches and transverse lines of increased density that suggest malnutrition, chemical analysis, and physical examination (Wing and Brown 1979:73). Most commonly applied in Caribbean archaeological research of paleopathologies of bones and dentition is physical examination (e.g. Tacoma 1985; Reuer and Reuer-Fabrizzi 1986; Budinoff 1987; Khudabux et al. 1987; Cashion-Lugo 1991; Maat and Smits 1992).

Frequently encountered paleopathologies of bones are rickets and osteomalacia, attributed to a vitamin D deficiency or to a lack of sufficient exposure to sunlight, scurvy, resulting from vitamin C deficiency, and hypovitamosis A, which leads to abnormalities in the shapes and the growth of bones. Chronic malnutrition, which might be reflected in reduced adult stature, is less identified (Wing and Brown 1979:83-88).

In some cases, repeated actions and tasks concerning food gathering and/or processing are thought to have caused stress on the skeleton, such as the grinding of cereals, which might leave polished facets in bones of the feet (Renfrew and Bahn 1991:385-386).

The paleopathology of the dentition also provides nutritional information. The nutritional quality of the diet for children influences the qualitative condition of teeth in the first place. In the second place, teeth are subjected to mechanical, chemical, and pathogenic stresses that are all strongly affected by dietary factors (Powell 1985:307).

Most occurring dental pathologies are enamel hypoplasia, which is a development arrest of enamel during the process of crown formation, dental caries, periodontal disease, and dental wear (Wing and Brown 1979:88-91). Dental wear is the erosion of the coronal enamel, caused by direct

---

7 The absence of griddles or grater teeth does not demonstrate the absence of manioc cultivation, as manioc might have been treated also like a pot vegetable, as is common among many recent manioc-consuming Amerindians (DeBoer 1975:420).

8 Nutritional deficiencies should appear in large proportions of a population, in order to exclude individual variations.

tooth-on-tooth contact or by substances such as grit. Attrition, the first form of wear, produces smooth contact facets, while the latter, which is called abrasion, produces a pattern of microscopic grooves and pits (Powell 1985:308). Dental wear may influence caries. Dental caries is a pathological condition which, without medical intervention, will lead to ante-mortem tooth loss (Powell 1985:313). Carious destruction of the teeth is deteriorated by diets including large proportions of soft-textured foods high in carbohydrates. No detailed paleopathological studies have been made for the Guadeloupe region.

1.3.4 Quantitative Analyses

The last phase in the research of pre-Columbian human diets involves the determination of the percentages of different foodtypes in a diet. This determination relies on different osteochemical analyses, based on ratios of the stable isotopes of nitrogen, strontium, or carbon and nitrogen. The most reliable analysis for the determination of shellfish and reef-resource ratios in diets of coastal populations is stable isotope analysis.

1.3.4.1 Stable carbon- and nitrogen-isotope analyses

Stable carbon- and nitrogen-isotope ratios of marine and terrestrial foods are sufficiently different to determine their occurring percentages in pre-Columbian diets from the corresponding isotope ratio in human bone collagen (Keegan and DeNiro 1988:320-321). The relative proportions of marine and terrestrial food groups can be determined. Among the latter, C_3 foods, such as manioc, and C_4 foods, such as maize, can be distinguished. Thus, a lifetime profile of the average subsistence of an individual is obtained. However, as Newsom (1993) points out, only environmental archaeological evidence provides more detail about precisely which species of plants or animals contributed to the diet.

The isotope method is particularly useful for detecting changes in diet. Van der Merwe et al. (1981) used it to examine the diet of the pre-Columbian occupants of the Orinoco floodplain in Venezuela. Their analyses revealed a shift from a diet based on C_3 plants around 800 BC to one based on C_4 plants by AD 400. This shift was affirmed by the abundant maize kernels and grinding equipment that were found for the later period.

Studies concerning stable carbon- and nitrogen-isotope analyses for pre-Columbian populations in the Caribbean have been executed by Keegan (1985, 1989[b]), Keegan and DeNiro (1988), van Klinken (1991)[9], and Stokes (1995).

Keegan and DeNiro (1988) identified the relative contributions of marine and terrestrial food resources in the diets of pre-Columbian coastal populations. Their analysis involved the study of the isotopic compositions of three indigenous land animals (iguana, hutia and land crab), and nine modern plants. Secondly, the isotopic compositions of modern fish, archaeological fish and sea turtle remains, and modern marine invertebrates, algae, and seagrass species were analysed. Finally, the isotopic compositions of these samples were compared to the isotopic compositions of collagen isolated from the human skeletal sample, which consisted of one individual from the early Hacienda Grande site on Puerto Rico, and 17 Lucayan Taino individuals from a later period from the Bahamas.

On the basis of these analyses, three dietary schemes were identified, the first consisting mainly of terrestrial foods with a small input from marine sources, the second consisting equally of terrestrial and marine resources, and the third consisting of about 70% of marine foods[10]. The Hacienda Grande individual relied for 93 ± 7% on terrestrial foods. On the basis of archaeological evidence, a diet consisting mainly of cultivated tubers and land crabs with a minor contribution of marine resources could be reconstructed for this early period. The later period is characterized by a shift from inland to coastal-settlement locations and by a shift towards a diet based on the increased consumption of marine foods (Cfr. Jones 1985). This shift was explained by Keegan (1985) as reflecting an optimal subsistence strategy.

Van Klinken (1991) found three similar dietary profiles for human skeletal material from four locations in the Caribbean. Stokes (1995:196) warns to approach his data carefully, as some seem to be contaminated. Results from the acceptable samples reveal a diet based almost equally on marine and terrestrial resources for post-Saladoid individuals from Saba, a diet based mainly on terrestrial food sources for individuals from the early Ceramic Maisabel site on Puerto Rico, and a diet based mainly on marine food with what appears to be a considerable input from C_4 plants for pre-Ceramic individuals from Aruba, Bonaire, and Curaçao[11].

---

9 See also Hoogland (1996) for a more detailed description.

10 Keegan and DeNiro (1988:320) demonstrated that a unique isotopic signature in bone collagen of pre-Columbian Bahamians is caused by different nitrogen-isotope ratios of food sources from seagrass environments or coral reefs compared to other marine environments.

11 According to van Klinken (1991:99), only maize could give comparable results, whereas Stokes (1995:196) suggests the use of Panicoid grasses, since no maize kernels have been found so far.

1.3.5 Final remarks

The variety and the development in the above mentioned disciplines in environmental studies in Caribbean archaeology, show that there is a growing interest in the studies of pre-Columbian subsistence and diet, and in environmental studies in general. Unfortunately, these disciplines are such specialized and complicated fields of study that they have often been used as a complete and independent research in itself. Very often it is not possible to execute an integrated research in three phases as Keegan (1987) proposed and executed. More of such integrated studies, first on site level and later on a regional level, especially for the later part of the pre-Columbian period in the Lesser Antilles, will be needed in order to create a more complete image of past subsistence systems and human behaviour.

1.4 OBJECTIVES

1.4.1 Research questions

The present study can be seen in the light of the above described studies and approaches concerning subsistence and diet of pre-Columbian societies in the Caribbean. Its case-study concerns the late pre-Columbian site of Petite Rivière. This site is situated on the island of La Désirade, near Guadeloupe[12]. It was partly excavated by the French archaeologist Pierre Bodu in 1984, and an additional small-scale excavation was executed by the author in 1995. First of all, this study should serve as an excavation report of the 1995 fieldwork campaign. Therefore, the archaeological research on La Désirade, the setting and earlier research of the site, as well as the objectives, the strategies, the methods, the results and the conclusions of this fieldwork will be described (chapter 3). Unfortunately, no excavation reports exist of the 1984 excavation campaign, which renders the data less reliable. The materials that were excavated during the 1984 and the 1995 campaigns, are described in chapter 4. Of these materials, the study of pottery asks a prominent place, as the cultural-chronological framework of the pre-Columbian period in the Caribbean is almost entirely based on the study and chronological classification of pottery[13]. Thus, in order to be able to place

12 See chapter 2 for information on the Caribbean in general and on the island of La Désirade in particular.

13 This regional cultural-chronological framework and its premises are described in paragraph 2.5.

the site chronologically and culturally within this regional framework, it is necessary to make a detailed description of the Petite Rivière pottery.

Secondly, there is also a need to examine the subsistence of the later pre-Columbian period in the Caribbean. Therefore, the most important objective of this study is to examine the subsistence system of the pre-Columbian inhabitants of the Petite Rivière site. Situated on the dry and desolate island of La Désirade[14], these inhabitants must have faced severe restrictions concerning available natural resources. For example, the availability of potable water sources, being one of the most important conditions for human settlement, must have been rather limited. The fresh water sources that do exist are often difficult to reach, and their water outlets change with the seasons. For the inhabitants of the Petite Rivière site, this will not have been a limiting factor, for near the site is situated a fresh water source. Nevertheless, this scarcity of surface waters in general, greatly affects flora, fauna, and the possibilities for horticulture or agriculture on the island. This condition is even deteriorated by the intense sun, the high evaporation rate, and the poor soils. Few land mammals will have been present, except for rather small species like iguanas and agoutis[15], so subsistence can be expected to have been greatly depending on marine resources. Notwithstanding these unconveniences, the pre-Columbian inhabitants of the site have been capable to survive at this place.

Therefore, the following objectives are considered to be important.

— Why were pre-Columbian Amerindians interested in the island of La Désirade?
— What natural subsistence and non-subsistence resources are available on the island and which might have been available at the time of interest?
— What sources can be archaeologically demonstrated to have been exploited?
— What was the subsistence system and diet of the pre-Columbian inhabitants of Petite Rivière like?

This study may provide an answer on these questions. It should not be forgotten, however, that both the 1984 and the 1995 excavations were small-scaled campaigns, and that therefore the quantity and the quality of information on pre-Columbian subsistence and diet are rather limited. Moreover, most of the documentation of the 1984 excavations is lacking, and the environmental

14 In this study the thought is accepted that the natural and climatological setting of La Désirade has not changed dramatically during the last 1500 to 1000 years (see paragraph 2.3.1 and 2.3.2, and Keegan 1992[b]). It is possible, however that before the coming of European settlers there were more trees on the island. This might have caused more humid circumstances, and it might also have influenced the presence of a more abundant fauna on the island, especially birds. The poor soils and the modest precipitation, however, do not seem to have allowed the flourishing of a vegetation that is much more abundant than it is nowadays.

15 It is possible that these animals were brought to the islands where they did not occur naturally by the Amerindians (Nokkert personal communication 1996).

(and especially paleo-environmental) information on la Désirade is scarce. Therefore, this study should best be seen as a test-case for a small-scaled integrated subsistence study, without expecting conclusions that could be interpreted on a larger scale.

1.4.2 Data and methods

In order to execute a structured research of the subsistence of the pre-Columbian inhabitants of the Petite Rivière site, the three-phase method of Keegan (1987) and Stokes (1995) will be used in chapter 5.

In the first phase of this method, it must be determined as precisely as possible what sources might have been available and exploited. Ecological and/or economic models can be used to identify the types of data which should be collected, and to determine the techniques to analyse them [16]. Economic models such as optimal foraging theory, have been used in the Caribbean by Keegan (1985, 1987, 1992[a]). On the basis of the shortcomings of this method (see paragraph 1.3.2.4), it was decided not to use it in this study[17]. As economic premise, it is only supposed that "animal resources closest to the site would have been used most" (Wing and Reitz 1982:27). For an archaeological case-study, Flannery's (1976[a]) inductive site catchment analysis would be suitable, as a result of its empirical character[18]. However, such an explanation method would be best applied in a final stage of a research, not in the predictive phase. In this first phase, Haviser's (1987[b], 1989, 1991) point-pattern technique could be used. This technique was used to examine pre-Columbian human adaptation to the insular semi-desert environments of Bonaire and Curaçao. Following this approach, topography, geomorphology, geological features, potable water sources, major drainage basins, soils suitable for maize and/or manioc cultivation, mangroves, tidal salt areas, clay sources, the presence of other archaeological sites, and the presence of non-subsistence resources, such as lithic and clay sources are quantified for the catchment area of a site[19]. The point pattern technique is used to quantify the relative values of those characteristics, by calculating the percentage of points, representing a characteristic at radii of 1 km, 2 km, and 3 km from the settlement (Haviser 1989:5). The 1 km radius was represented by 21 points, the 1-2 km radius by 78 points, and the 2-3 km radius by 124 points, all points being separated by 400 m intervals. A characteristic is thought

---

16 Ethnohistoric accounts might also provide general information on Amerindian subsistence systems, but, as mentioned before, detailed study of these resources does not fit in the timetable of this study.

17 The concept of carrying capacity was not used either, due to uncertainties concerning essential factors as supply and population growth in archaeological studies.

18 To overcome the problem of environmental change, Flannery's device (see paragraph 1.3.2.4) should be taken into consideration.

19 Haviser uses a 3 km radius instead of the usual 5 or 10 km radius for the site catchment areas in his studies.

to be significant when its catchment percentage ratio is higher than the island percentage ratio for that characteristic (Haviser 1991:239-240). The point-pattern technique will be used for the Petite Rivière site in chapter 5, in order to predict the natural resources that were available near the site and that may have been exploited in pre-Columbian times.

In a second stage, the archaeological record will be used in order to obtain empirical data on subsistence activities. Evidence on subsistence can be found in faunal remains, which might represent different habitats and the extent to which they were exploited (Wing 1968:103), shellfish remains, plant remains, artefacts used for the production and processing of food, and human skeletal remains. The archaeological materials from the Petite Rivière site will be described in chapter 4, and analysed in relation to the general subsistence research of this study in chapter 5. Unfortunately, it has not been possible to recover plant remains as no flotation procedures could be carried out due to a lack of time and as no analyses of such remains could be arranged in the time available for the working out of this project.

The final phase in the research program involves the determination of the relative importances of natural resources in the diet. Osteochemical analyses, such as stable isotope analysis, provide a direct measurement of the percentages of different food types in long-term consumption profiles, and as such the isotope method provides a refining of the data on subsistence that were already put forward in the two first steps of analysis.

1.4.3 Concluding remarks

The combination of these research phases should provide an image of the subsistence system of the pre-Columbian inhabitants of the Petite Rivière site. The following chapters will be used to give an introduction in La Désirade's natural setting, and in the regional cultural setting (chapter 2), to describe the 1984 and the 1995 fieldwork (chapter 3) in order to provide a context for the archaeological materials, which will be described and analysed in this study (chapter 4). Finally, the complete three-fold analysis, as described under data and methods, will be carried out (chapter 5) in order to come to a better understanding of subsistence systems for the Lesser Antilles in the later part of the pre-Columbian period

2 THE SETTING

2.1 INTRODUCTION

2.1.1 Introduction

La Désirade is one of the least known islands of the Caribbean. The Caribbean islands (fig. 2) are divided in the Greater and the Lesser Antilles. They extend in an arc from the South-American Mainland, separating the Caribbean Sea from the Atlantic Ocean. Most of the islands are at visible distances and are generally assumed to have functioned as stepping stones for colonizing groups (Rouse 1992:1).

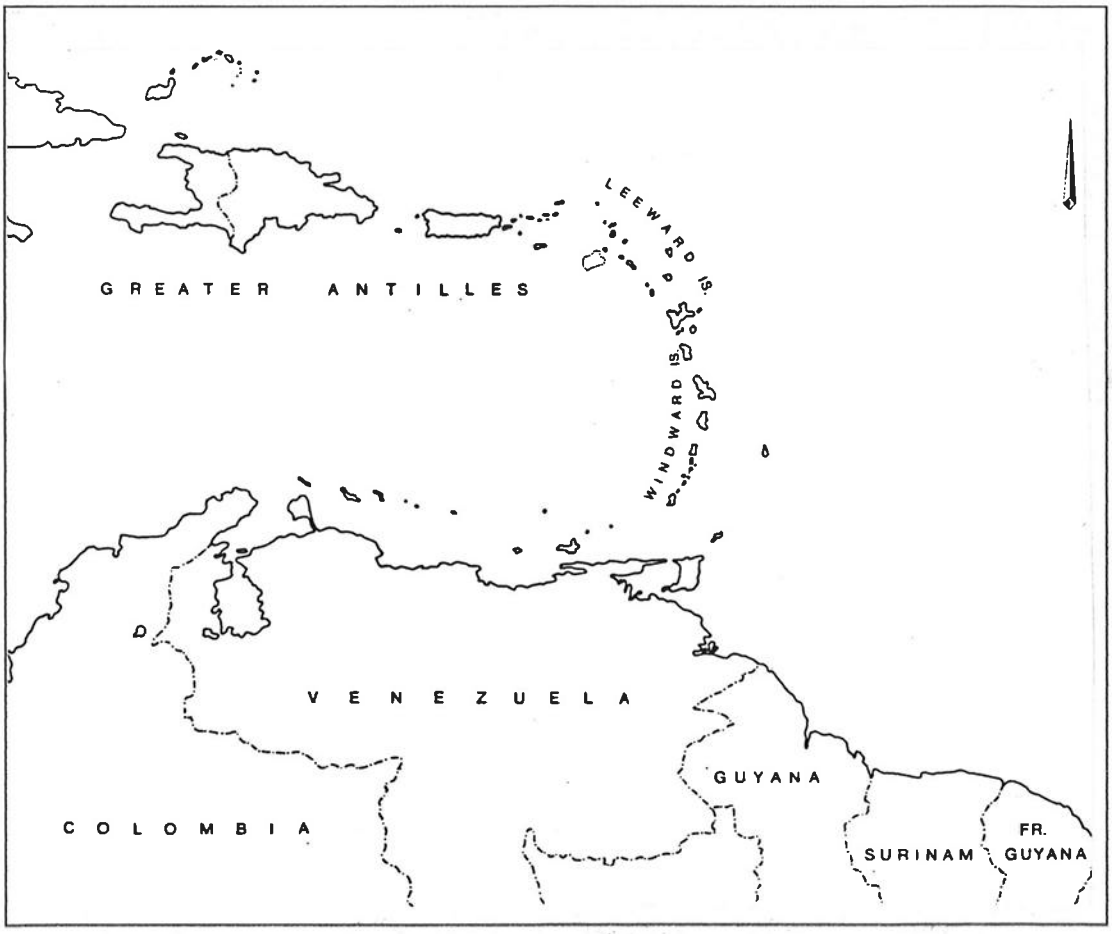


Figure 2. Map of the Caribbean (After Hofman 1993:6)

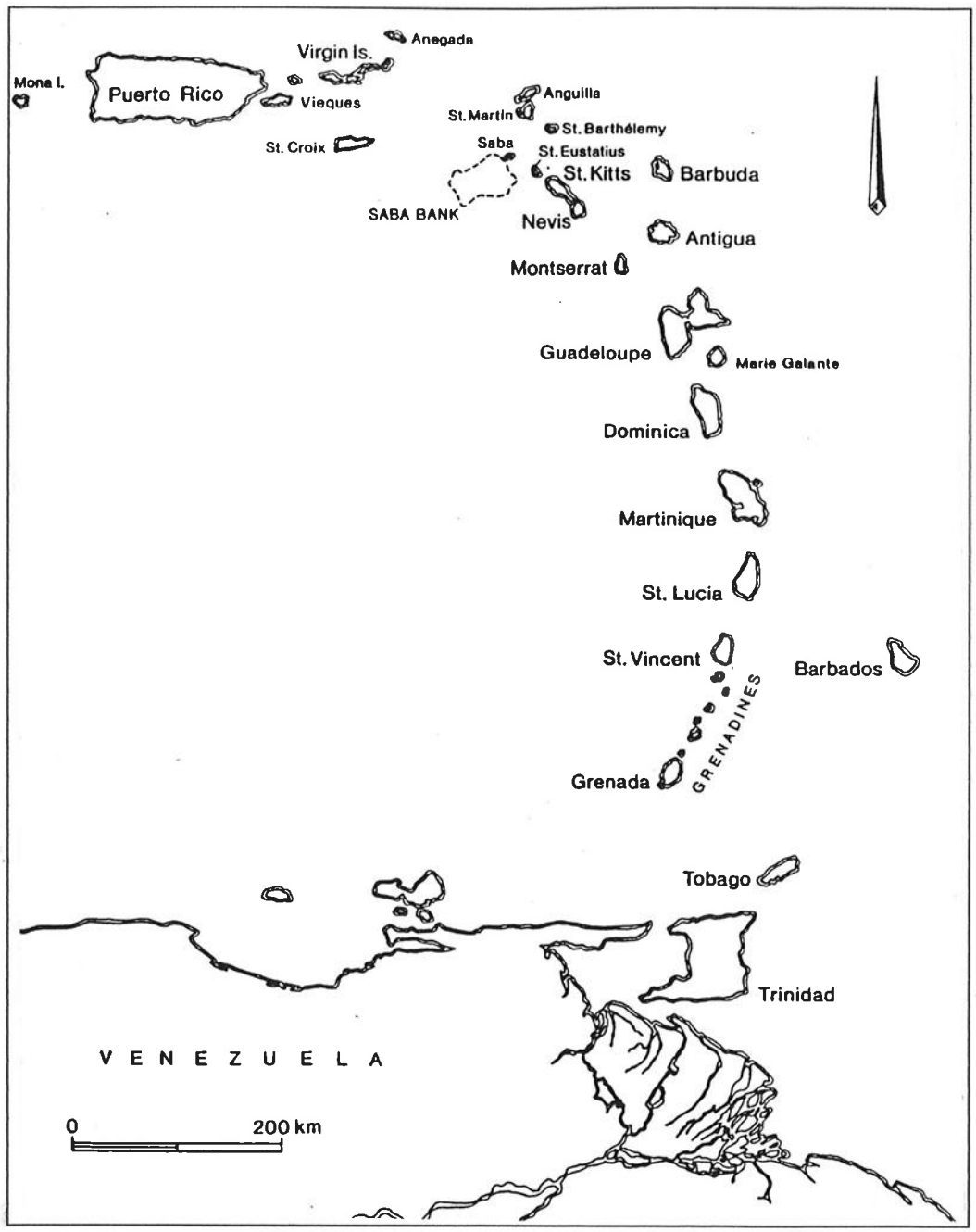


Figure 3. Map of the Lesser Antilles (After Hofman 1993:7)

The Lesser Antilles (fig. 3) are divided in the Windward Islands, extending from the island of Trinidad to Martinique and Dominica, and the Leeward Islands, extending from Guadeloupe to the Virgin Islands. The island of La Désirade is situated at the east of Guadeloupe (fig. 4, page 21). The Greater Antilles, consisting of the islands of Cuba, Hispaniola (Haïti and the Dominican Republic), Puerto Rico and Jamaica are located in the north-western part of the Caribbean Sea. They are connected to the South-American mainland by the chain of the Lesser Antilles.

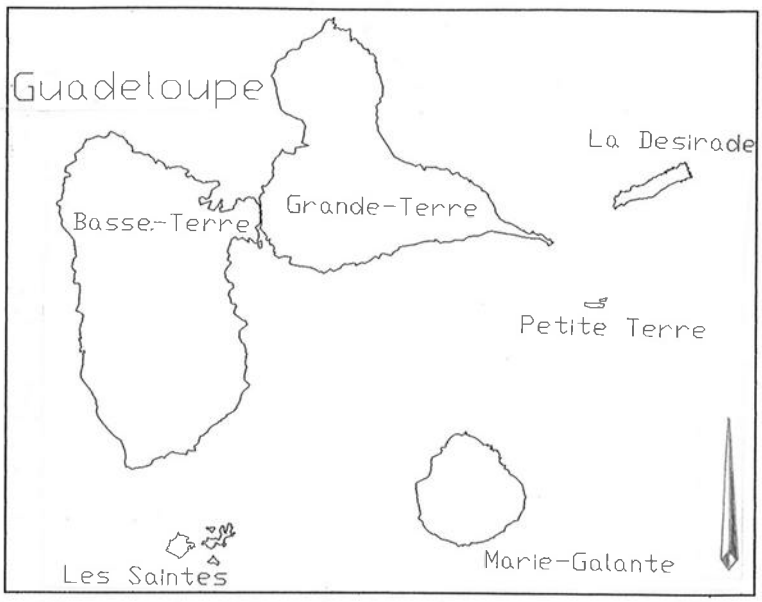


Figure 4. Map of Guadeloupe and it's nearby annexes

North of Dominica, the chain of islands splits in an outer-arc and an inner-arc. The outer-arc, the so-called chalk-islands, comprises (from south to north) Marie-Galante, La Désirade, the eastern part of Guadeloupe (Grande Terre), Antigua, Barbuda, St. Barthélemy, St. Martin, Tintamarre, Anguilla and Sombrero. These islands consist of predominantly marine sediments on an old volcanic foundation. They are characterized by pre-Miocene volcanic sediments consisting of andesite, dacite, tuff and agglomerate, which in turn have been intruded by diorite and quartz diorite. In the early Miocene period the volcanic and intrusive centres were bevelled and capped with shallow water limestones ranging in age from Miocene to Recent (Fox and Heezen 1975:444; Uchupi 1975:28). The volcanic islands of the inner-arc comprise (from north to south) Saba, St. Eustatius, St. Kitts, Nevis, Montserrat, the western part of Guadeloupe (Basse-Terre), Les Saintes, Dominica, Martinique, St. Lucia, St. Vincent, The Grenadines and Grenada. They are of younger geological age and consist of active and recently extinct volcanoes.

The inner-arc has been formed due to tectonic movements of the Caribbean plate towards the Atlantic plate around 45 million years ago. In this process, the Atlantic plate was forced under the Caribbean plate. This caused radial cracks through which the plastic interior, which formed the volcanoes of the inner-arc, could escape. The outer-arc was formed by the same geological process, but the islands were moved in an easterly direction due to the extensibility of the shelf. The islands were submerged, covered with sea sediments and uplifted by tectonic movement (Fox and Heezen 1975:444-445).

2.1.2 La Désirade

The Guadeloupean annex of La Désirade is situated between 61 and 61.5 degrees western longitude and between 16 and 16.22 degrees northern latitude. It is located 12 km off the Pointe des Châteaux, the easternmost tip of Grande-Terre (Guadeloupe). It belongs to the same continental platform (Butterlin 1956:274; Westercamp and Tazieff 1980:123).

La Désirade is an 11 km long and 2 km wide table mountain, with a volcanic substratum, dominated by a 6.5 km long uninhabited limestone plateau, La Montagne. This plateau reaches 276 m in its western part and 175 m in its east part. At the western part of the island it is bordered by limestone hills, upto 150 m in height, and at the eastern part it is bordered by different plateaus, with heights varying between 35 and 95 m (Barrabé 1954:614; Lasserre 1961[b]:885).

The north coast of the island is rather inaccessible due to its abrupt cliffs, some of them exceeding a height of 200 m, and the strong and unpredictable sea currents. The south coast, on the contrary, is characterized by a more gentle slope between the plateau and the southern coastal plain that extends between the two extremities of the island. This coastal plain is sheltered from the wind, and the reefs, that border the coastline, protect it from strong sea-currents. Therefore, it is a preferable place for habitation[20] (Lasserre 1961[b]:887). At La Désirade, 17 pre-Columbian sites have been discovered uptil now (see appendix 1). Nine of them are situated on the southern coastal plain, four on the central plateau, and four on the slopes and plateaus in between (Bodu 1984, 1985[a-c]).

2.1.3 Petite-Terre de Désirade

The archipel of Petite-Terre (fig. 5, page 23) belongs to the municipality of La Désirade. It consists of two west-east oriented islands, separated by a small and shallow channel. Situated approximately 12 km south from the Pointe des Colibris (Désirade) and at 7.5 km south-east from the Pointe des Châteaux, it is part of the continental platform of Grande-Terre (Fink 1972:274). The islands consist of one coral bank of which the central part has been immersed, and they are bordered by reefs.

The highest elevation (8 m) is to be found at the 2.5 km long and 600 m wide southern island, Terre-de-Bas. The west and north coasts of Terre-de-Bas are low, and they are bordered by salinas. The south and east coasts are rocky with modest limestone slopes. The northern island, Terre-de-Haut, is 1.1 km long and 200-300 m wide. Its main part is rocky with modest limestone slopes.

---

20 La Désirade's 1600 inhabitants live in six hamlets, extending along the Route Départementale 207: Les Galets, Les Sables, Le Bourg or Grande Anse (capital), Le Désert, Le Souffleur and Baie-Mahault.

Nowadays, the islands of Petite-Terre are uninhabited, but in pre-Columbian times they may have been exploited for their nutritional resources, and in the eighteenth century they were used for growing cotton (Lasserre 1961[b]:916). Uptil now, five pre-Columbian sites have been discovered (Nicholson 1975; Bodu 1985[c]). They are all situated at the north and south coasts of Terre-de-Bas (see appendix 1). According to Bodu (1985[c]), these sites seem to have been occupied temporarily and simultaneously in late pre-Columbian times by small groups, looking for shelter or a stopping place on their way between Marie-Galante and La Désirade. Although fresh water sources are lacking, the islands could have been attractive because of their abundances of sea-turtles[21], fish, shellfish, and land crabs, especially in the small channel separating the two islands. Because neither artefacts nor detailed archaeological records are available, reconsideration of earlier reports, and more detailed studies are needed to come to a better understanding of pre-Columbian occupation and/or exploitation of the two islands.

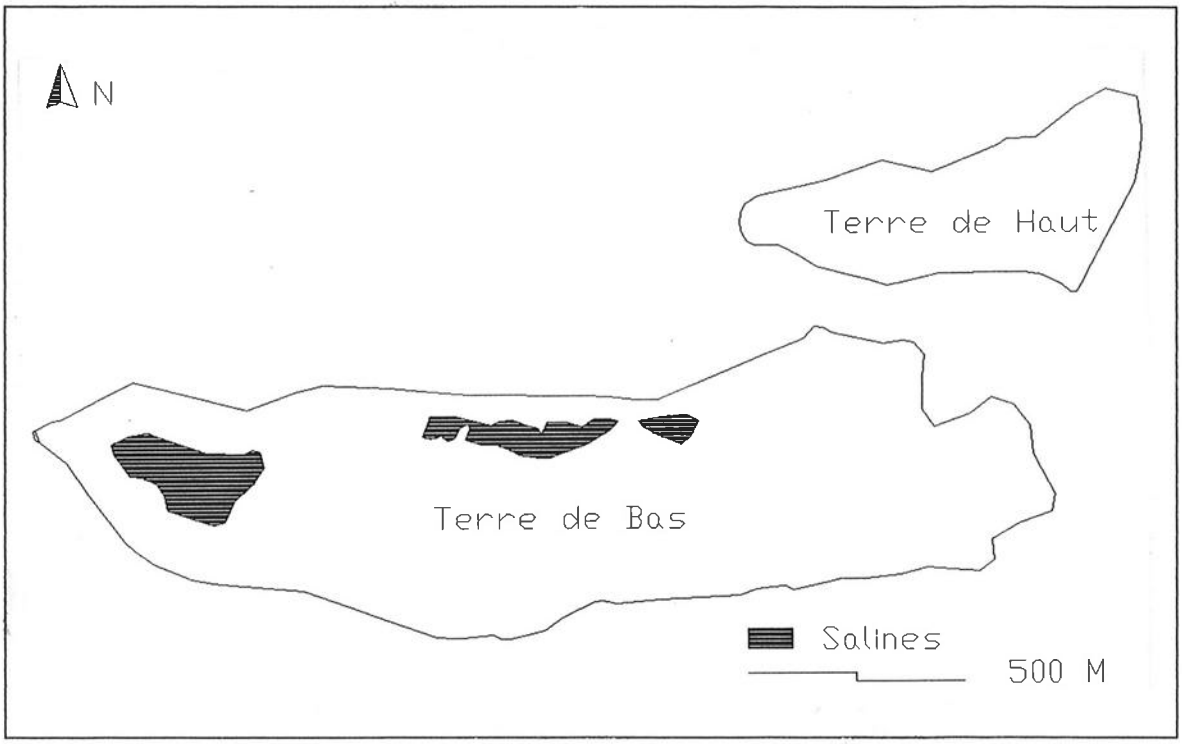


Figure 5. The archipel of Petite-Terre

[21] See paragraph 2.4.1.

2.2 GEOLOGY

2.2.1 Geology and morphology

The geology of La Désirade (fig. 6) is described here in order to create a framework for the occurrence and the use of exploitable raw stone material. The geological significance of La Désirade lies in its igneous basement which is better exposed than on any other island capped with limestone (Fink 1972:275). The basement complex occurs as lava with greenschist, interbedded chert and radiolarite[22], the latter showing the sub-marine origin of the lava (Barrabé 1954; Fink 1972; Donnely 1975:672-674; Uchupi 1975:28).

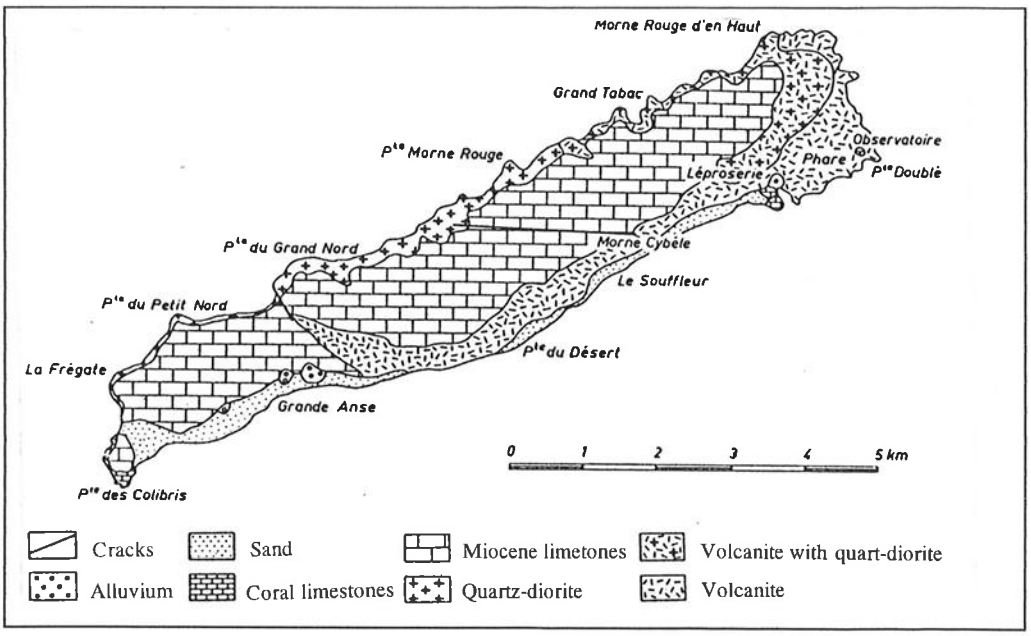


Figure 6. Geological map of La Désirade (After Weyl 1966:259)

The volcanic rocks eroded into a platform on which a 50 m cap of limestone was deposited. Tectonic movements lifted it to more than 200 m height, folded the limestone and created cracks that border the central plateau to the west and connect the Rivière and Morne Cybèle ravines. A thick limestone cornice borders the plateau (Barrabé 1942:150; Mitchell 1953; Butterlin 1956:278; Lasserre 1961[b]:887; Weyl 1966:259-261);(fig.7, page 25).

22 Hills between La Pointe Mansénilier and Baie-Mahault, in the south-east part consist of radiolarite (Westercamp 1978:5; Westercamp and Tazieff 1980:126-127).

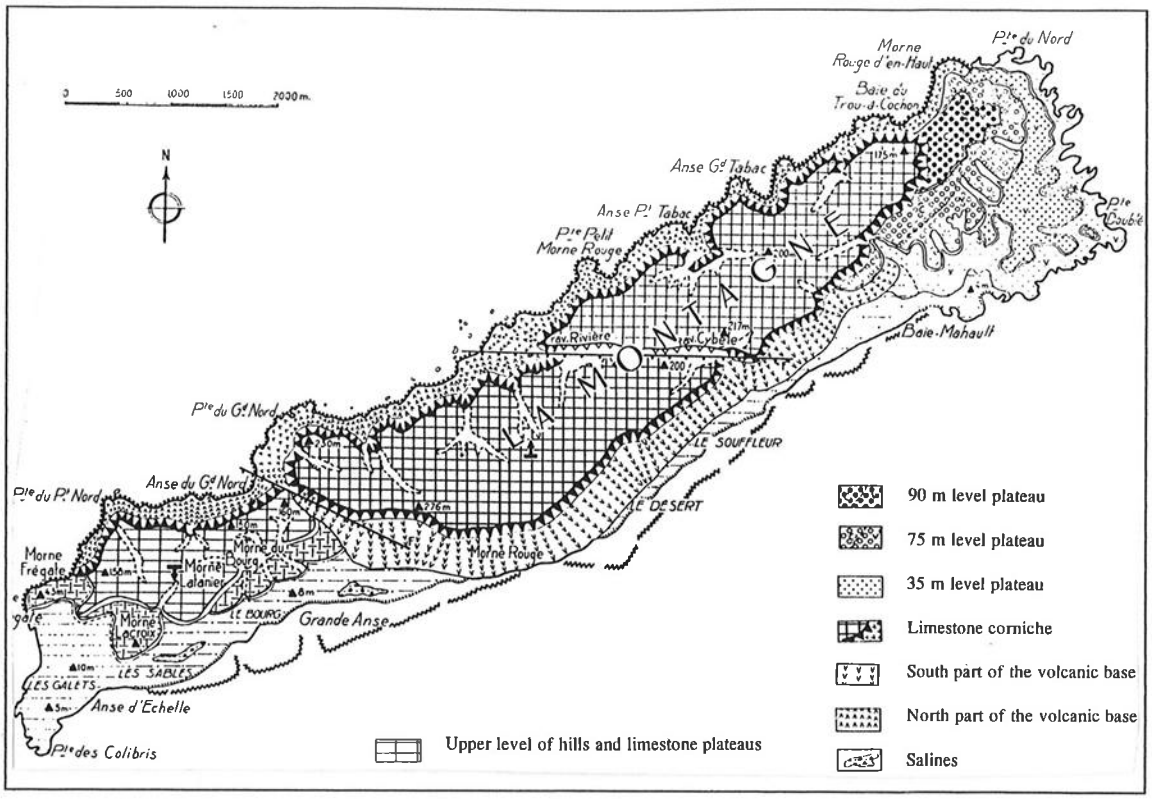


Figure 7. Morphological map of La Désirade (After Lasserre 1961[b]:886)

Parts of the cornice and the plateau were hollowed by carstification processes. Basins, which can conserve rain water for a long time, were created. Some of these worn out surfaces have been covered with dispersed and shallow decalcification clay occurrences (Lasserre 1961b:889-890). At the eastern part of the island, coastal platforms eroded at 35 m, 75 m and 95 m, consisting of limestone that covers accumulations of volcanic boulders in limestone and coral cement (Barrabé 1954:618; Lasserre 1961[b]:887). The northern and eastern part of the island consist of volcanic material. The southern coastal plain, on the contrary, has a limestone covering and consists of elevated reefs (Westercamp and Tazieff 1980:125).

2.2.2 Sedimentology and coastal dynamics

Sea-movements cause erosion of coastal lines. Unfortunately, the magnitude and the velocity of this process at La Désirade is not known.

At the plateau, the thin layer of loose soil, covering the limestone bedrock, is not protected by dense vegetation. Therefore, erosion easily takes place. The eroded sediments of the plateau are mainly deposited on the slopes and partially they move further down. At the southern coastal plain sedimentation seems to take place very slowly. Only a very thin sedimentation layer can be found there.

No information on coastal dynamics and changes in sea level is available. Yet it is important to know to what extent the landscape has changed the last 1500 - 1000 years to get to an understanding of changes in the presence of natural resources, the accessibility of the shore and the preservation of archaeological sites, caused by erosion, sea level changes, and tectonic movements.

2.3 NATURAL SETTING

2.3.1 General information

No information is available on seasons, precipitation, insolation, temperature, humidity and winds in pre-Columbian times. It is generally assumed that no great changes have taken place the last 1500 - 1000 years (Keegan 1992[b]). Therefore, modern data are presented here to create an image of the environment in which the pre-Columbian occupation of the Petite Rivière site could have taken place.

The Antilles are situated in the zone of the north-Atlantic trade-winds with dominating winds from north-east to south-east direction. For the Guadeloupe archipel, three seasons can be distinguished. The first is a dry and rather fresh subtropical season with a moderate north-eastern wind from January to April. The second is a tropical season with moderate rainfall with strong eastern winds in May and June and finally the rainy period, is an extremely warm and humid subequatorial season, with subsiding trade-winds between July and December (Bouchet 1992:3).

The island of La Désirade receives approximately 1036 mm/year from precipitation. The fact that an evaporation average has been measured to 1830 mm/year explains the great dryness of the island. La Désirade and the other annexes are also the warmest parts of Guadeloupe as there is more insolation and less nebulosity. The annual average temperature is above 27° C and stable during the year, while the relative humidity of the air is rather high, with an average of 81% (Lasserre 1961[a]:143-210; 1961[b]:767-806; Bouchet 1992:3-6).

2.3.2 Environmental changes

Changes in climate, soils, vegetation and sea levels that might have taken place since pre-Columbian times are difficult to estimate. Still, these changes are important when considering pre-Columbian exploitation of the environment. Early colonial descriptions might reveal information on this subject. In the seventeenth and eighteenth centuries the small annexes of Guadeloupe were

already known to be the 'arid rocks' as we know them now. La Désirade was thought to be ignored and only to be good for lepers.[23]

Recent information on coastal dynamics and climatological and environmental changes since pre-Columbian times was not available at the 'Organisation de Recherche Scientifique pour les Territoires Outre-Mer' (O.R.S.T.O.M.) in Pointe-à-Pitre, nor at the 'Institut de Géographie Nationale' (I.G.N.) in Paris. As for coastal changes, studies have been made for the Bahamas (e.g. Keegan 1992[b]). Keegan (1992[b]:5) examines long-term processes of coastline development, which relate to patterns of settlement, and short-term changes that have affected the survival of abandoned sites. Six coastline types were identified and studied. These included eolianite, fossil coral reef, beach rock, salinas, tidal creeks, and sand beaches. Eolianites and fossil coral reefs seemed to have undergone only minor changes during the past 500 years, and for beach rock formations no evidence of tectonic uplift could be found. For the salinas, forming a dynamic border between land and sea, it could not be assumed that they have remained unchanged, even over a period of 500 years. Relative sea level changes seem to be insignificant for the period AD 700 to 1500, so prehistoric living surfaces have not been inundated. However, erosion of sediments is thought to have had a destructive effect on prehistoric sites (Keegan 1992[b]:8-10). For La Désirade, this situation could be similar. If accepted that fossil coral reef, constituting important parts of the island, has undergone minor changes the last 500 years, and, if accepted that sea level changes probably are insignificant for this period, it can be assumed they caused no site destruction. However, influence from tectonic movements can be expected as Grande Terre (Guadeloupe), which is on the same plate as La Désirade, is slowly submerging. The only changes might have taken place at the salinas near the capital Beauséjour, and as they cover a modest percentage of the island, even their influence might be considered non-important. However, at the plateau serious site destruction has taken place due to erosion of sediments, containing archaeological material, except for those in natural depressions in the limestone bedrock (Hofman and Hoogland 1994). An other important phenomenon is the caving in of the coast as a result from strong wave action which always occurs around La Désirade. This might have greatly influenced the landscape and the presence of archaeological sites.

As for the Guadeloupe region no data are available on what the situation in pre-Columbian times might have looked like, modern data on hydrography, pedology and vegetation are presented here to get a better understanding of the natural setting[24].

---

23 " Je crois que cette île est la plus misérable des Antilles, et celle où la terre est la moins capable de production" (Chevalier de Bourlamaque, 1763, *Mémoire abrégé ou réflexions sur l'état actuel de la Guadeloupe et des changements que l'on estime devoir faire dans ce gouvernement pour le bien de l'Etat et la Colonie*. Archives Nationales, Basse Terre).

2.3.3 Hydrography

The hydrographical network of La Désirade has adapted to the geological structure. Mountain streams of the southern part of the Plateau have an irregular water outlet and stream to the north and to the east. Furthermore, some permanent water resources exist under the cornice and near the coasts (fig. 8, page 29), and those of Baie-Mahault, Cybèle, Rivière and near l'Emballage are still being used (Lasserre 1961[b]:890-891; Petit 1989:3).

As a result from transportation through limestone, this water is calcareous, chlorous, and rich in minerals. Sometimes it exceeds the maximum admissible concentrations. In its present state, only the water from the Baie-Mahault sources is potable, except for the Ravine Bouille source. The other sources do not have a sufficient bacteriological quality (Petit 1989:11), although it might have been better in the past because of less environmental pollution. Several sources are known to have been used and to have supported the needs of La Désirade's 1600 inhabitants far into the 1960's (Petit 1989). Therefore it can be assumed that its pre-Columbian population might well have been provided with potable water. Furthermore, there is no reason to assume that above mentioned sources did not exist in pre-Columbian times, although the possibility that water courses of potable sources changed or disappeared as a result of environmental changes should not be excluded.

2.3.4 Pedology

As a pedological map of La Désirade does not exist, information on pedology is limited.
Soils at La Désirade are poorly developed, because of warmth, dryness, strong winds and the limestone subsoil. They are clayish, which implies that they do hold water, but they do not release it to the plant roots easily. Furthermore, they do not drain well and they are sticky when wet and brick-hard when dry (Sealey 1992:86). The plateau and the southern coastal plain, where cultivated zones are located (fig. 9, page 29), can not be used intensively because of the poverty of the soils, but they could have been used for slash-and-burn agriculture. Slash-and-burn agriculture at the plateau was common practice until the late 1960's (Bariteau 1968:21-22) and now and then is still used. At the southern coastal plain small fields are being cultivated for household use.

Regarding the fact that probably no great climatological changes have taken place, it is likely that La Désirade's pedological conditions do not differ greatly from those in pre-Columbian times. Extensive slash-and-burn agriculture, common to agricultural Amerindian societies, will have been possible, especially at the central plateau.

---

[24] Although very scarce since La Désirade is thought not to be important enough to be intensively studied.

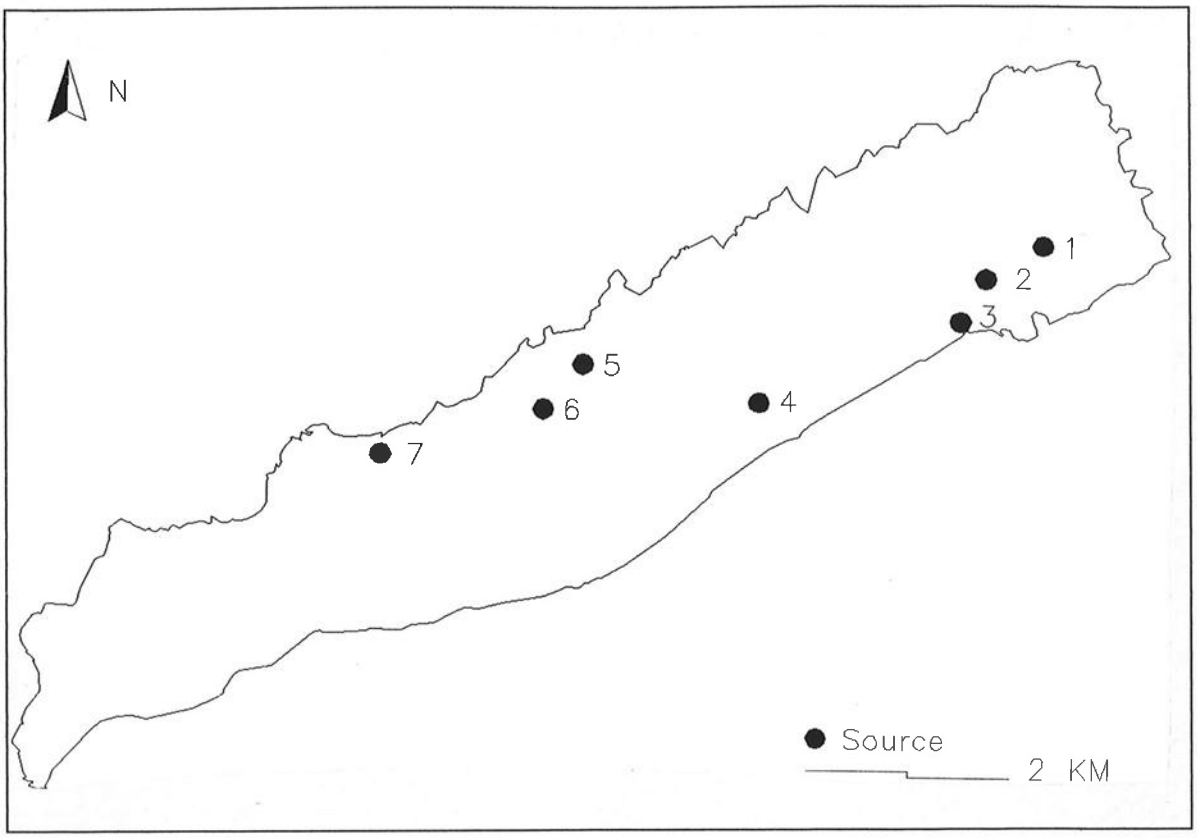


Figure 8. Map of the fresh water sources at La Désirade (After Petit 1989)

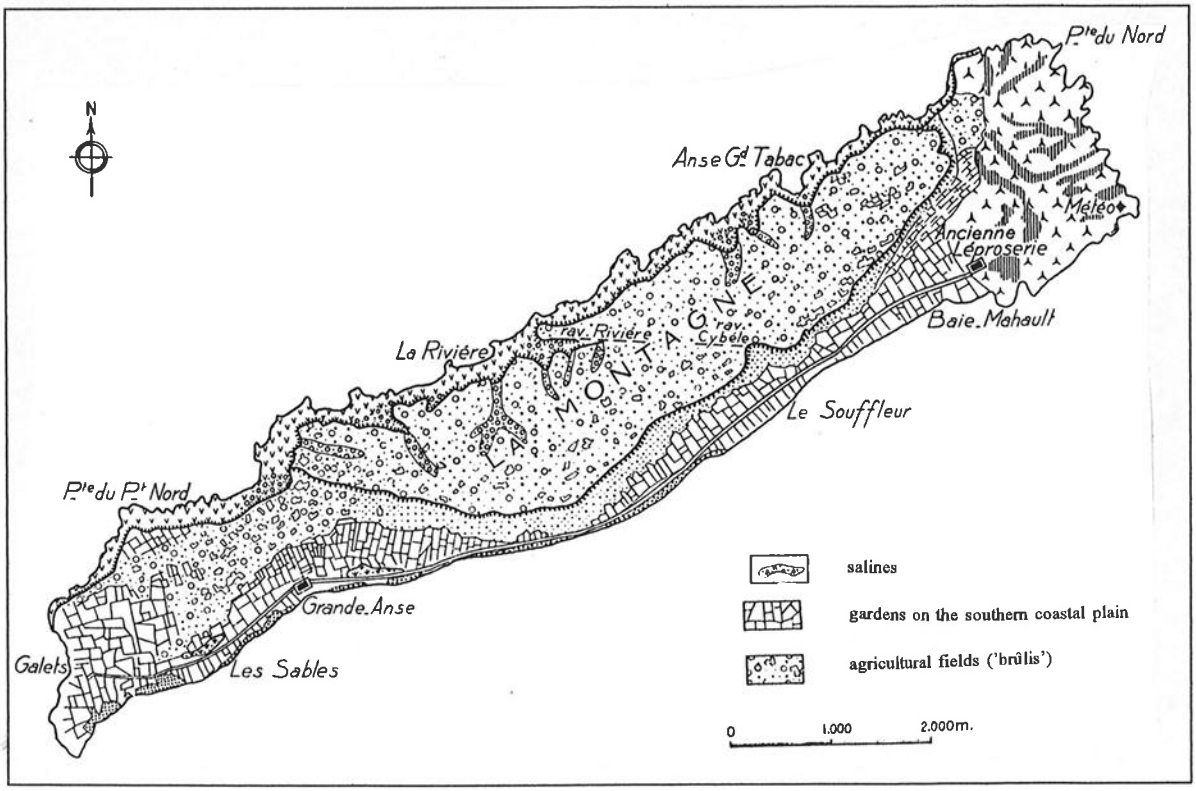


Figure 9. Map of the soil use at La Désirade (After Lasserre 1961[b]:905)

2.3.5 Vegetation

La Désirade's limited precipitation and poorly developed soils strongly influence the characteristics of its vegetation. The plateau, to begin with, is densely covered by a vegetation that prefers moderate circumstances. On the other hand, the limestone slopes are sparsely covered by a low vegetation that prefers dry and rocky environs, e.g. rosemary and heliotrope. This vegetation is followed by a small shrub zone, that dominates almost the whole island except for the southern coastal plain. This plain is sparsely covered by a coastal vegetation that prefers dry and sunny circumstances, which is characteristic for the limestone islands. It is composed of small-leaved thorny brushwood and cactaceous and herbaceous sorts. At the sandy beaches on this plain, a vegetation preferring acid circumstances, like lianas can be found (Bouchet 1992:11-12).

Climatological and pedological changes will not have influenced the vegetation greatly since pre-Columbian times. It is assumed that by then it was also low, rather dispersed and adapted to dry circumstances (Bouchet personal communication 1995). However, the vegetation will have diminished due to larger scale habitations, cultivated areas, and the introduction of grazing domesticated animals, like sheep and goats, in colonial times.

2.4 COLONIAL AND RECENT INFORMATION

2.4.1 Short colonial history

The colonial history of La Désirade is hardly known and sparsely documented. Some authors (e.g. Lasserre 1961[b]:884) claim that Christopher Columbus discovered La Désirade on his second journey in November 1493 and named the island 'Desirada', the desired one[25]. In the journals of Columbus, however, the discovery of La Désirade and/or Petite Terre is never mentioned (Jane 1930). It is only in the seventeenth century historic account of Father Breton that Petite Terre and La Désirade occur in the description of the islands surrounding Guadeloupe.

---

25 Désirade, située au vent des autres Antilles fut la première que Colomb découvrit, à son second voyage, le 3 novembre 1493: c'est ce qui lui fit donner le nom de Désirade (Boyer-Peyreleau, E.E., 1825, *Les Antilles françaises, particulièrement La Guadeloupe, depuis leur découverte jusqu'au 1er novembre 1825:322*).

> "Il y a autour de la Guadelouppe nombre de petites îles fort agréables. Les Saintes sont les plus belles, où les sauvages mesme ont encore quelques jardins à cotton. Les habitants de la Guadeloupe y vont varer et tourner la tortue. Marie-Galande et La Désirade n'en sont pas loin ny la Petite Terre esquelles nous allons aussy dans la saison pour tourner les tortues" (Breton 1647:32).

Other references, although very basic, can be found in the French-Carib and Carib-French dictionaries of Father Breton (1665, 1666). In these dictionaries, the islands of les Saintes (*Caároucaéra*)[26] and Marie-Galante (*Aïchi*) are described for their economic importance to the Amerindian inhabitants of Guadeloupe (*Caloucaéra*); (Breton 1665:211,280,409-410; 1666:116,352). On the contrary, Petite Terre (*Cayóhori*)[27] and La Désirade (*Oualíri*)[28] are only mentioned once. The attention of the European newcomers was mainly focused on the island of Guadeloupe (Jane 1930:319). As for the islands in which the Europeans were interested, various historic accounts on the Island Caribs are available (e.g. de Rochefort 1658; de La Borde 1674).

Not many documents on Amerindian and colonial occupation of La Désirade can be found in the archives[29]. This documentation starts in 1648, when La Désirade was annexed by the 'Compagnie des Isles de l'Amérique' and subjected to the government of Guadeloupe. By then, no Amerindian or European occupation was known at La Désirade. The only importance of La Désirade in colonial times was its use as exile for lepers between 1728 and 1958, and for 'mauvais sujets' (unacceptable subjects) of France between 1763 and 1767 (Lasserre 1961[b]:891-894). The determining factor in colonial occupation was set in the difficulties incurred for agriculture and the unsuitability for sugar plantations because of the poor soils. The soils, however, are appropriate for cotton cultivation and cotton plantations have been in use from the end of the sixteenth century until the abolition of slavery in 1848 (Bariteau 1968:6-7; Lasserre 1961[b]:896).

2.4.2 Recent population

Nowadays, La Désirade is one of the least developed islands of the Caribbean. It has a rural economy. Fishing plays an important part in the basic daily food economy, and agriculture and breeding are the most important sources of income for own consumption. Agriculture offers a year-round yield, but nevertheless, many people work on Guadeloupe. At the poor and sandy 'terres d'en bas', extending on the southern coastal plain, millet, maize, beans, manioc, cucumbers, and sweet

---

26 Carib name.

27 "Islet entre la pointe de la grande terre & la desirade" (Breton 1666:379).

28 "*oualíriche-éntina*, i'ay passé par la Désirade" (Breton 1666:274). *Oualíri* was translated as 'Les nieves, les Anglais y sont' (Breton 1665:416). Nevis was translated as *hueléme* (Breton 1666:259). Hoff (personal communication 1996) assumes that Breton made a mistake and that *Oualíri* refers to La Désirade.

29 Les Archives Nationales de La Guadeloupe, Basse-Terre.

potatoes are cultivated. The soil is fertilized with seaweed, manure or ashes. At the 'terres d'en haut' on the hills and the plateau, where a thin clayish layer assures good yields, cotton, maize, beans and manioc are cultivated (Bouchet 1992:14).

2.5 CULTURAL SETTING

2.5.1 Introduction

In the early 1930's professor Irving Rouse (Yale University) started to build a chronological framework for the cultural developments in the Caribbean, which he described from a cultural-historical point of view on the basis of pottery, estimating that pottery comprises 90 percent of the artefacts recovered from pre-Columbian sites in the Antilles (Rouse 1977). He used groups of pottery[30] to delimit material cultures and people behind cultures and their cultural development was based on the development of style[31] (Rouse 1964; Hofman 1993:26). A pottery style, complex or phase is defined as the entire repertoire of a people built into its pottery during one single cultural period. A style is characterized by a specific material, shape, decoration or ware and technology. These characteristics are used to define areas, periods, peoples and cultures (Rouse 1964; Hofman 1993:26). A series of styles, named after the type-site with the suffix -oid, is a resemblance of styles within one line of development. Local divergents are called subseries, named after the type-site with the suffix -an (Rouse 1964, 1986, 1989, 1992; Vescelius 1980; Hofman 1993:26).

Rouse explains the pottery developments and their dispersions through the region by migrations of Ceramic people from the South-American Orinoco region, through the Lesser Antilles to the Greater Antilles. He explains different stages by boundaries/contactzones between Ceramic and pre-Ceramic people (Hofman 1993:27; Rouse 1986, 1992).

Since most archaeological studies have focused, until recently, on the refinement of the chronological framework, the current state of affairs of the Ceramic series will be described with an emphasis on decorative characteristics. From the Petite Rivière site at La Désirade Suazoid ceramics, belonging to the so-called Post-Saladoid series, had been reported (Petitjean-Roget 1983). Until recently, it was thought that the most northward distribution of Suazan ceramics had been found in the southern part of Martinique, and not further north than the Windward Islands

30 Uptil now it has been impossible to fit other material categories into the chronological framework for the Ceramic period. They will be described in chapter 4.

31 Cfr. Childe, V.G., 1929, *The Danube in Prehistory*. Clarendon Press, Oxford.

(Allaire 1991). Therefore, the emphasis of the description (based on Hofman 1993) will be on the Post-Saladoid series of the Windward Islands.

2.5.2 Saladoid series

The Saladoid series, named after the Saladero site (Venezuela), is the earliest pottery tradition in the Orinoco region. The Saladero style evolved from the Ronquinan Saladoid, which had developed in the middle Orinoco near the town of Parmana in the second millennium BC (Roosevelt 1980:193-196). During the first millennium BC, the people producing Ronquinan Saladoid pottery, which is characterized by bell-shaped bowls with red or white-on-red painted geometric designs, curvilinear incised lines, wedgeshaped lugs and modelled-incised adornos on lugs, strap handles and vessel walls, are thought to have moved into the Guyanas, where a Cedrosan Saladoid subseries developed (Rouse 1986, 1992). Cedrosan Saladoid and Huecan Saladoid subseries, local divergents of the Saladoid series, are the earliest pottery traditions on the islands.

2.5.2.1 Huecan Saladoid subseries

Recent research has led to the postulation of a migration of people with a pottery culture from the South-American mainland towards the Lesser Antilles as early as 500-350 BC, preceding the Cedrosan Saladoid. This pottery, for which dates range from 500/350 BC-AD 100, has been named Huecan Saladoid, after the La Hueca site (Vieques). Except for Vieques, Huecan Saladoid ceramics have been found at Grenada, Union Island (Grenadines), St. Vincent, Martinique, Guadeloupe, Marie Galante, St. Martin (Hofman in press) and Puerto Rico (Hofman 1993:29-30). Characteristic are the zoned-punctation, zoned incised crosshatching (zic), curvilinear incision, incised nubbins and small zoomorphic adornos (figs. 10-11); (Chanlatte Baik 1981, 1983; Rouse 1992; Hofman 1993:29-31).

2.5.2.2 Cedrosan Saladoid subseries

Cedrosan Saladoid pottery (figs. 10-12), for which dates range between 200 BC-AD 600/850, has been named after the Cedros site (Trinidad). On the Lesser Antilles it has been found from Trinidad on, upto the Virgin Islands and part of the Greater Antilles (Puerto Rico and the eastern point of

Hispaniola);(Rouse 1989, 1992; Hofman 1993:29). Cedrosan Saladoid consists of three phases[32]. Characteristic for *Early Cedrosan Saladoid* (250 BC-AD 400) is a combination of plain, zic and painted white-on-red ware, with curvilinear and linear incisions, modelled animal or human heads on tabular lugs and nubbins (Rouse 1952, 1986:141, 1992: 81; Rouse and Alegría 1990). *Cedrosan Saladoid with Barrancoid influences*[33] (AD 300-500) is restricted to the Windward islands and is characterized by areal painting, curvilinear incisions and modelled-incised anthropomorphic and zoomorphic adornos (Rouse 1989). Finally, *Late Cedrosan Saladoid* (AD 400-600/850) is characterized on the Greater Antilles by changes from white-on-red painting to straight parallel lines and to an overall coating with red slip, and on the Lesser Antilles by the increase in complexity of white-on-red painting and the appearance of polychrome painting (Rouse 1992; Hofman 1993:32-34).

2.5.3 Post-Saladoid Series

Around AD 600/850 the Cedrosan Saladoid subseries comes to an end and divergent local developments start to take place on the Antilles (Hofman 1993:35). Therefore, a description is made of the Post-Saladoid series on the Greater Antilles, the Leeward Islands and on the Windward Islands.

2.5.3.1 Post-Saladoid on the Greater Antilles (fig. 10)

On the Greater Antilles the **Ostionoid series**, divided by space and/or time into four subseries, develops. The ***Ostionan Ostionoid*** subseries (AD 600-1000) is named after the Punta Ostiones site (Puerto Rico) and has been found on the western part of Puerto Rico and in the Dominican Republic. Ostionan pottery comprises a number of styles, occurring on the Dominican Republic, Haiti, Jamaica and Cuba. Ostionan pottery is thin, hard, smooth-surfaced plain pottery, with red-slip ware and decoration in red painted bands and geometric modelled figures (Rouse 1992:95,109).

The ***Elenan Ostionoid*** subseries (AD 600-1200) is named after the Santa Elena site (Puerto Rico). Similarities between Ostionan and Elenan Ostionoid make it hard to distinguish the two styles. The Elenan subseries developed on eastern Puerto Rico and the Virgin Islands with a Montserrate style (AD 600-800) with painted strips in red, buff or black in negative geometric

---

32 Mattioni and Bullen (1970) distinguish an Insular, Modified and Terminal Saladoid for the Lesser Antilles.

33 The Barrancoid series developed on the lower part of the Orinoco from 1500 BC onwards (Hofman 1993:33).

designs and the smudging technique and a Santa Elena style (AD 800-1200) with thick, coarse pottery, painted plates/griddles, zoomorphic and anthropomorphic modelling and parallel incised lines (Rouse 1952:344-346).

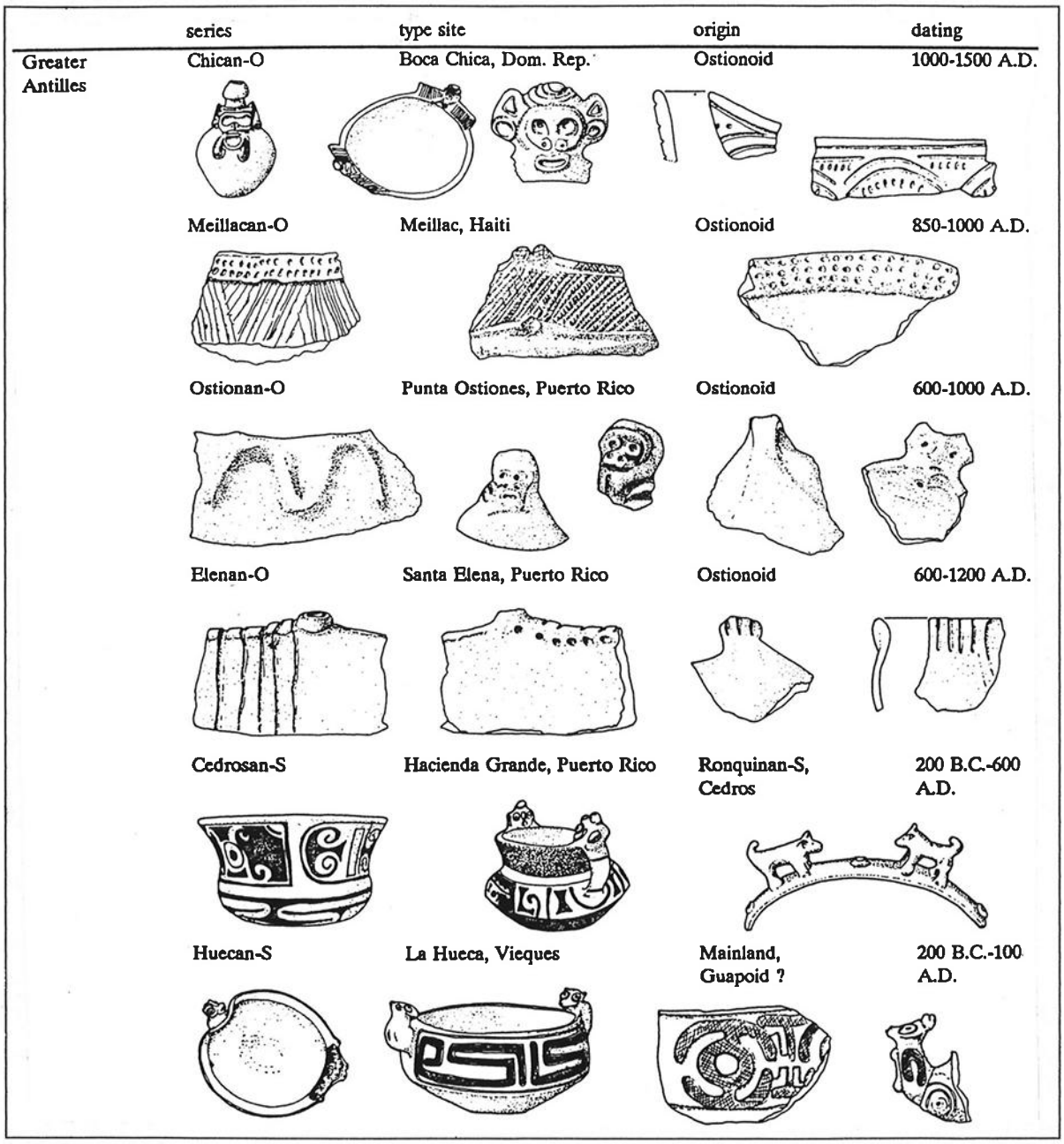


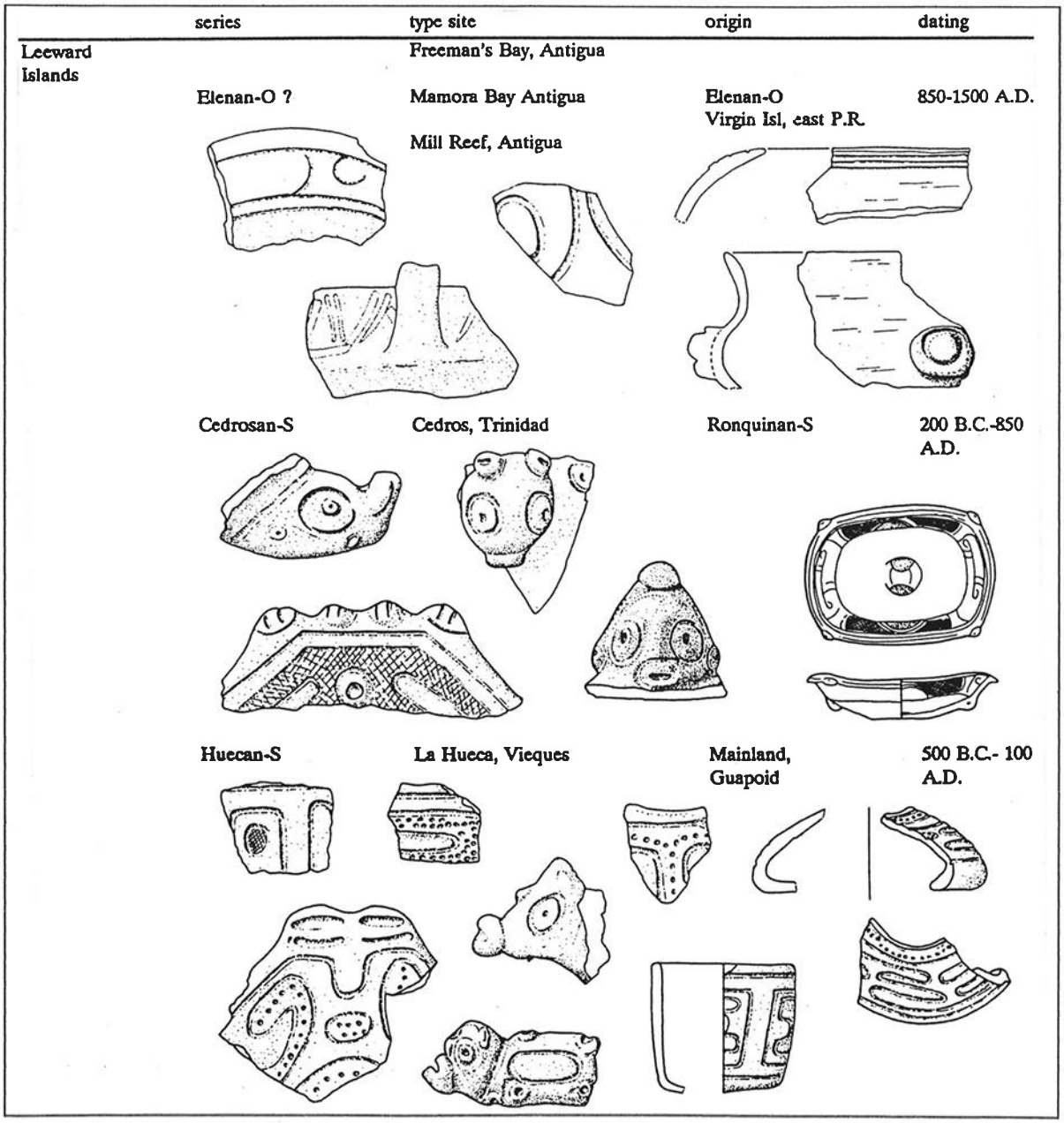
Figure 10. Chronological chart for the Caribbean, the Greater Antilles (After Hofman 1993:47)

The ***Meillacan Ostionoid*** subseries (AD 850-1000), named after the Meillac site (Haiti), evolved around AD 800 from the Ostionan Ostionoid to the west. The north-eastern part of Hispaniola has been suggested as its place of origin, with a spread to Cuba and Jamaica (Rouse 1992). Within the subseries a number of styles are distinguished on the northern Dominican Republic, south-west Haiti, Jamaica and Central Cuba (Hofman 1993:37). Meillacan Ostionoid pottery is characterized

by zoned, obliquely hatched lines or punctated bands, anthropomorphic and zoomorphic lugs (Rouse 1992).

The ***Chican Ostionoid*** subseries (AD 1000-1500), named after the Boca Chica site (Dominican Republic), developed in the Dominican Republic out of the Meillacan and Ostionan subseries. Several local variations exist on the Dominican Republic, Hispaniola, Puerto Rico, the Virgin Islands, Haiti, and eastern Cuba (Hofman 1993:40). This pottery is characterized by Meillacan style incision and Cedrosan Saladoid modelled incised lugs (Rouse 1952, 1992; Hofman 1993:36-40).

2.5.3.2 Post-Saladoid on the Leeward Islands (fig. 11)



Until recently, the Post-Saladoid developments on the Leeward Islands have been attributed to Elenoid or Elenan Ostionoid subseries. However, recent studies (Hofman 1993) revealed strong ***Chican Ostionoid*** influences from AD 1300 onwards, at that time the dominant subseries on the Greater Antilles and the Virgin Islands (Hofman 1993:156). Recently, Rouse (et al. 1995) have proposed to include the Leeward Islands complexes within an enlarged Troumassoid series divided into a Mamoran subseries in the Leeward Islands and successive Troumassan and Suazan subseries in the Windwards. ***Mamoran Troumassoid*** (AD 500/600-1500) is named after the Mamora Bay site (Antigua). It comprises three styles. The *Mill Reef style* (AD 500/600-800/1000) consists of pottery with straight parallel painted white-on-red designs, two parallel incised lines on the inside of inward thickened rims, with scratching and vestigial handles (Rouse 1992; Hofman 1993:38). The *Mamora Bay style* (AD 800-1200) is characterized by pottery with red slipped surfaces replacing bicolour and polychrome painting, broadlined curvilinear or parallel linear designs on the outside wall of shallow vessels, scratched surfaces, folded/thickened rims, and rare lugs and no handles (Rouse 1992). The *Freeman's Bay style* (AD 1200-1500) consists of pottery with deeper and narrower, more irregular and U-shapes incised lines, scratched surfaces and dimpled bases (Rouse et al. 1995).

2.5.3.3 Post-Saladoid on the Windward Islands (fig. 12, page 40)

Troumassoid series

On the Windward Islands, the Cedrosan Saladoid developed into a Troumassoid series around AD 500/600. Some scholars consider the Troumassoid series to be a local development from the former Cedrosan Saladoid subseries, based on similarities in red, black and white painted decorations and wedge-shaped lugs (Rouse 1986:149, 1992).

The Troumassoid series (± AD 700-1000) is named after the Troumassée site (St. Lucia). The first to define the series was McKusick (1960), who originally distinguished a Troumassée A phase (median date AD 430), later identified by Rouse (1992) as Cedrosan Saladoid with Barrancoid influences, and a Troumassée B phase (median date AD 730), later identified as the Troumassoid series on the Windward Islands.

Figure 11 (page 36). Chronological chart for the Caribbean, the Leeward Islands (After Hofman 1993:46)

These dates were based on samples from Grande Anse, Troumassée and Giraudy on St. Lucia (Rouse and Allaire 1978:462). Bullen and Bullen (1972) called this latter phase 'Calivinoid', after the Caliviny Polychrome decoration which is typical for this phase and which they had identified at the Caliviny site (Grenada).

Troumassoid pottery is characterized by thick, coarse and soft ceramics with inward thickened rims, legged, pedestal or annular bases, legged griddles and triangular griddle rims, scratched surfaces, polychrome painting with white, red and black or red and black combined with curvilinear incisions and modelled-incised designs on lugs. Clay spindle whorls make their first appearance, explained by an increasing production of cotton (Allaire 1991, Rouse 1992:129). Troumassoid vessel shapes comprise boat-shaped, kidney-shaped, bottomless, double, hemispherical, inverted-bell shaped bowls, cylindrical pot stands, jars and effigy bowls (Hofman 1993:39).

Troumassoid pottery is found widely over the southern Lesser Antilles. Bullen and Bullen (1966) also found evidence of 'Caliviny' traits in the Cupecoy Bay complex of St. Martin (Haviser 1987[a]). Most Troumassoid sites are coastal sites located on dry and infertile parts of dry islands, for example the Troumassoid sites on Martinique, St. Lucia, and Barbados (Allaire 1977, 1991; Friesinger et al. 1986; Drewett 1991; Harris and Hinds 1995).

Suazoid series

The Suazoid series (± AD 1000-1500) is named after the Savanne Suazey site on Grenada (Bullen 1964). McKusick (1960) had previously named this series Micoid on the basis of his archaeological studies on St. Lucia. He distinguished two styles, namely Choc and Fannis. However, as mentioned above, it was recently proposed to distinguish Troumassan Troumassoid and Suazan Troumassoid subseries (Rouse et al. 1995).

In fact, not much information is available on the Suazan Troumassoid subseries, which has been considered until recently as a Suazoid series. Debates are continuing on the subject of its origin. Some authors (Allaire 1977, 1984; Davis and Goodwin 1990; Haag 1965:244; Rouse 1986:151; 1992:131) are convinced that the Suazoid series developed locally from its Saladoid ancestor. Their hypothesis is based on similarities in iconography. According to Rouse (1992:130-131) it can be seen as the climax of a continuous period of local development. Others (Bullen and Bullen 1976:7-8; McKusick 1960) reasoned, however, that the Suazoid series resulted from a population movement from South-America, that it can be related to Island Carib occupation, and that it marks an abrupt break with the preceding Saladoid series (Bullen 1970). Boomert (1987:24-26), on the contrary, is convinced that Suazoid series developed out of the Troumassoid series.

This hypothesis is based on great similarities he noted in Troumassoid pottery co-occurring with Suazoid pottery.

The non-ceremonial component of the Suazan pottery is among the least finished and crudest pottery of the Antilles (Hofman 1993:42). Suazan ceramics are characterized by scratched and/or finger-indented surfaces, linear or areal red painting, simple parallel incisions, circles, scrolls, anthropomorphic adornos and figurines, clay pestles and legged vessels and griddles (McKusick 1960; Allaire 1977; Hofman 1993:42). There are local forms of lugs, including pegs and heads with flat faces, applique noses and eyebrows, punctated or slashed mouths, nostrils and eyes and pierced ears. Other types of clay artefacts include pot stands, spindle whorls, stamps, figurines and pierced cylinders known as loom weights (Allaire 1977). Tempering materials include crushed shell and tiny pebbles (Rouse 1992:129).

Suazan pottery is most abundant on Barbados, where it occurs at several sites (Bullen and Bullen 1966, 1968[a]; Hackenberger 1986; Drewett and Harris 1987; Drewett 1991, 1995). It also occurs at the Fitz-Hughes and Indian Bay sites on St. Vincent, and at the Banana Bay and Savanne Suazey sites on the Grenadines and Grenada (Bullen and Bullen 1968[b], 1972; Kirby 1976), at sites on Tobago (Kirby 1976; Drewett 1991), at several sites on St. Lucia (McKusick 1960; Bullen and Bullen 1970, 1976; Bullen et al. 1973; Kirby 1976; Rouse and Allaire 1978; Friesinger et al. 1986), at the sites of Macabou, Pacquemar, and Anse Trabaud on Martinique (Allaire 1977, 1991), at sites on Carriacou (Sutty 1976, 1985), at Mustique (Hinds and Harris 1995), at St. Croix (Bullen and Bullen 1974), and at St. Kitts (Allaire 1974). Until recently it seemed that Suazan pottery was not recorded north of the southern part of Martinique (Allaire 1991). Recent studies revealed that Suazan pottery occurs on the annexes of Guadeloupe, e.g. at Folle Anse on Marie-Galante (Allaire 1992), at Grande Anse on Terre de Bas, les Saintes and at the site of Morne Cybèle-2 on La Désirade (Hofman 1995[a]). At Guadeloupe itself, Suazan pottery has been found at the sites of Anse-à-l'Eau, Couronne, Morel lV, and Gros Cap (Bullen and Bullen 1973; Allaire 1992) and Anse à la Gourde (Bloo in prep.).

Most Suazan sites, like Troumassan sites, are coastal sites that are situated in dry and infertile environments on dry islands, for example the Suazoid sites on Martinique, and Barbados (Allaire 1977, 1991; Drewett 1991).

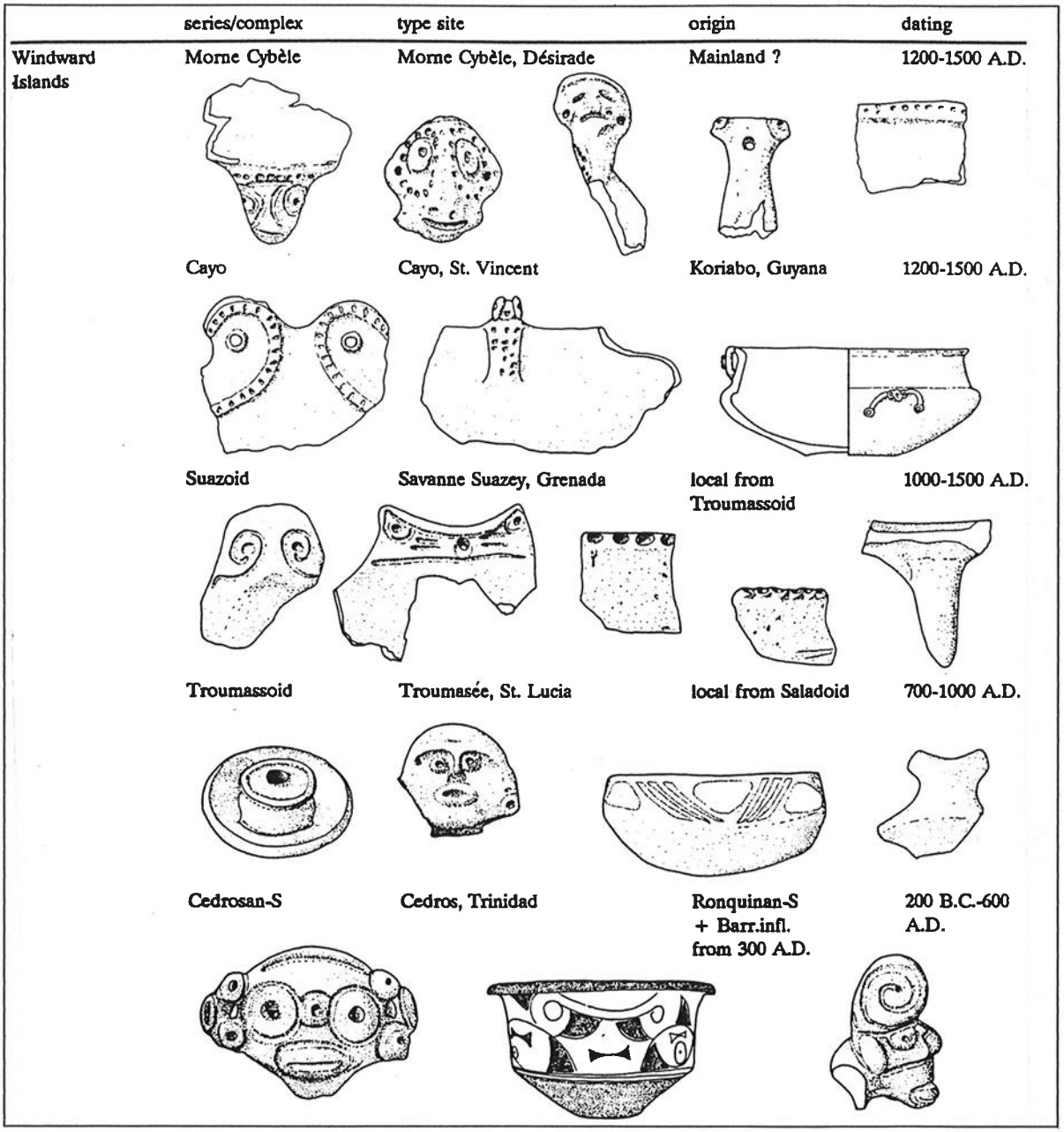


Figure 12. Chronological chart for the Caribbean, the Windward Islands (After Hofman 1993:45)

Cayo complex and the Suazan influenced style of Morne Cybèle

The Cayo complex (AD 1250-1500) developed in the southern Windward Islands of Tobago, St. Vincent (Kirby 1974), the Grenadines and Dominica (Boomert 1986; Allaire and Duval 1995) at the end of the pre-Columbian period. Cayo pottery, named after the Cayo river on the northeast coast of St. Vincent, is characterized by incisions on a flat rim, cone shaped collar and body,

perforated small adornos, multi-convex vessels with anthropomorphic faces and caraipe temper[34] (Hofman 1993:42).

The existence of Cayo should be seen as independent from either Troumassoid or Suazoid associations (Allaire and Duval 1995:255). Cayo, associated with the Island Carib population and representing an offshoot of the Koriabo complex of coastal Guyana, is assumed to have replaced Suazoid on the Windwards (Boomert 1986:56).

In 1984, the late pre-Columbian sites of Morne Cybèle were discovered on the island of La Désirade by Pierre Bodu (1985[a]), and more recently excavated by Hofman and Hoogland (1994). Morne Cybèle pottery differs from the Cayo pottery in all respects, but stylistic similarities to the Suazan decorated pottery should not be overlooked (Hofman 1993:42). The Ceramic assemblage of the Morne Cybèle-2 site, which has been dated at AD 1230-1326, belongs to the Suazan Troumassoid subseries with its scratched surfaces and incised decorations of broad and shallow lines. The Morne Cybèle-2 ceramics can be clearly distinguished from the ceramics from the Morne Cybèle-1 site, which has been dated at AD 1440-1460. The latter are decorated in most cases by geometric, anthropomorphic and zoomorphic adornos often embellished by punctation, suggesting a later and local development (Hofman 1995[a]:7-10). Recently, similar ceramics have been found at the site of Anse à la Gourde (Hofman personal communication 1996).

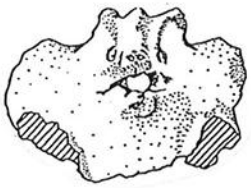
2.6 FINAL REMARKS

The described natural and cultural setting determines the framework in which studies at the pre-Columbian Petite Rivière site are to be fit. Its location on the dry and infertile island of La Désirade, with its modest precipitation and high evaporation, and its poor soils and vegetation, causes restrictions for use and exploitation of the island and for pre-Columbian subsistence. However, no severe restrictions appear to have been opposed by the hydrographical network. For this reason, it will be interesting to study exploitation and subsistence by the pre-Columbian inhabitants of the Petite Rivière site.

As for the Petite Rivière pottery, which will be described in chapter 4, post-Saladoid ceramics are of special interest. Unfortunately, these are difficult to distinguish because only a small percentage of the pottery is decorated. Therefore, solid information on its characteristics and distributions has

[34] Caraipe temper is dried, charcoaled and crushed bark of the *Licania apetala* or Kwepi tree (Boomert 1986).

to be gained. Furthermore, data on site locations and subsistence of other post-Saladoid sites will have to be compared with those from the Petite Rivière site in order to be able to place this site in a regional cultural and environmental context.



3 SURVEY AND TEST EXCAVATIONS

3.1 ARCHAEOLOGICAL RESEARCH ON LA DESIRADE

3.1.1 Introduction

Archaeological research on La Désirade in general has been small-scaled and poorly documented. Therefore, it has been and is still necessary to re-examine sites with surface-surveys and additional test-units. Few detailed studies have been made of the archaeological material from earlier legal and illegal surveys and excavations. These materials have been deposited in the depot of the archaeological Edgar Clerc museum in Le Moule, Guadeloupe. Only the collections from the Pointe Doublé, Morne Baie-Mahault (Bodu 1984), Morne Cybèle (Hofman 1995[a]) and Petite Rivière (de Waal this volume) sites have been studied in more detail.

3.1.2 Earlier research[35]

From the early 1950's onwards the Fathers Pinchon and Guilbert and other local inhabitants of La Désirade have been collecting surface finds, mainly pottery, of different archaeological sites. Even some illegal test units have been made, e.g. at the Voûte à Pin site. Father Maurice Barbotin (1991) and Edgar Clerc, the latter being the founder of the Guadeloupe Historical Society and since 1972 director of Antiquities, were the first in the 1950's to document their archaeological visits, findings and test units, although very superficial. Moreover, most of the documentation has been lost in the course of time. An other small-scale archaeological visit has been reported by Nicholson (1975). Henri Petitjean-Roget (1983), director of Antiquities between 1984 and 1992 and curator of the departmental Schoelcher (Pointe-à-Pitre) and Edgar Clerc museums, visited some archaeological sites on La Désirade. He allowed Pierre Bodu, a French archaeologist, to work on Guadeloupe and its annexes in 1984 and 1985. At La Désirade, Bodu discovered and surveyed the archaeological sites of Les Sables, Pointe Mansénilier, Léproserie, Pointe Doublé, Morne Baie-Mahault, Le Cocoyer, Grotte de Grande Anse/Beauséjour, Anse des Galets, and Trou Canard and he executed

35 See appendix 1.

test units at the sites of Anse Petite Rivière, Morne Cybèle-2, and Les Sables (see appendix 1 and fig.77a).

In 1992, a regional archaeological service was created which was a part of the 'Direction Régionale des Affaires Culturelles' (D.R.A.C.) of Guadeloupe and André Delpuech was appointed as regional archaeological curator. From 1993 onwards, the D.R.A.C. works in conjunction with Leiden University (The Netherlands) at the realisation of an archaeological map of Guadeloupe and its annexes. Within this framework, Hofman and Hoogland (1994) and de Waal (this volume) executed surface-surveys and test units at the sites of Morne Cybèle-1 and -2, Pointe Doublé, Morne Baie-Mahault, and Anse Petite Rivière on the island of La Désirade.

3.2 SETTING

The pre-Columbian Petite Rivière site is located near Anse Petite Rivière (fig. 13), Baie-Mahault, La Désirade. The main part of the site is the property of the local Lallanne family, but the part with the densest surface distribution, approximately 80 m, is French territory. The site was discovered in 1952 by the Desiradian Father Pinchon, and it was rediscovered in 1983 during construction activities. Late Saladoid and Suazoid pottery was reported and it became clear that the site was threatened by illegal collectors and by various building activities (Petitjean-Roget 1983:7-9).

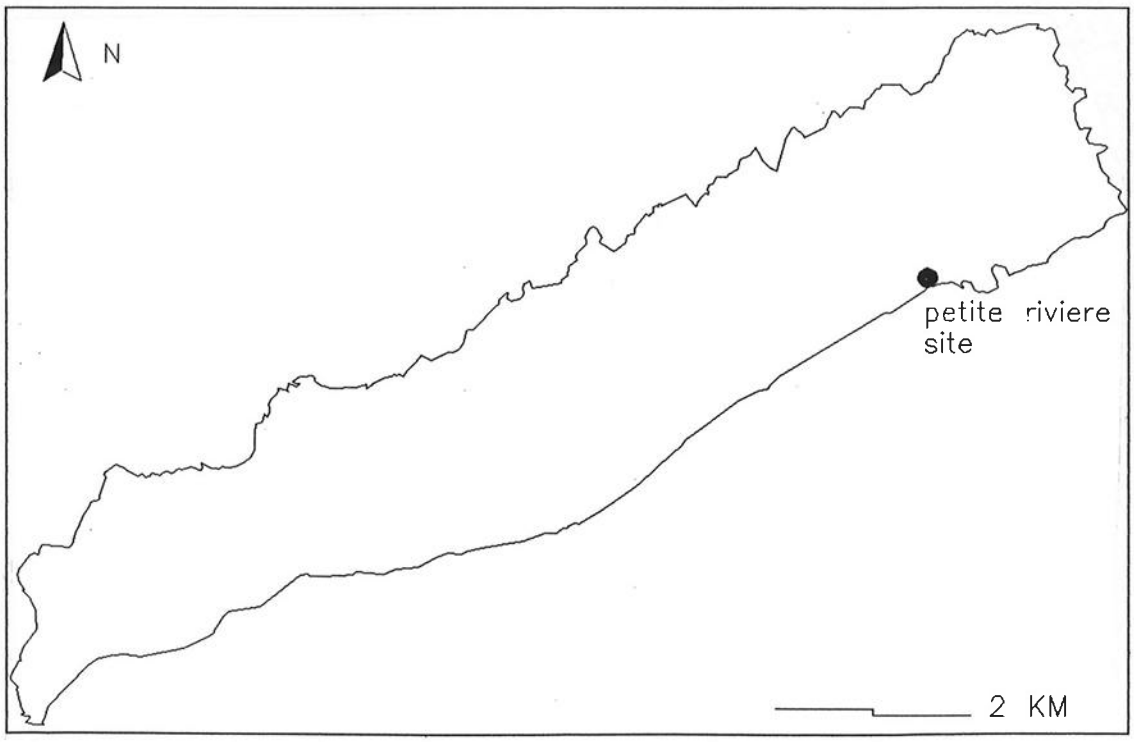


Figure 13. Location of the Petite Rivière site

Petite Rivière bay consists of a sandy beach, a flat intermediate level and a coastal plain that consists of a compact clayish soil with some herbs and thorny bushes, covering a limestone bedrock. The Petite Rivière site is situated on the coastal plain. At the northern side it is enclosed by the 'Route Départementale', on the southern side by the beach and the sea. Near the site two gullies are situated. One is a permanent water course which results from the Petite Rivière source. The other is nowadays dry. It runs over the central part of the site but it has its origin on the slopes of the plateau. Probably, these circumstances created a preferable situation for pre-Columbian occupation. Moreover, the Petite Rivière bay is protected from the sea, that is always very turbulent around La Désirade, by a coral barrier with a reef. Therefore, possibilities for easy fish and shellfish gathering are created and the open sea is easily accessible through openings in the barrier.

3.2.1 Earlier Research at the Petite Rivière site

Local inhabitants have been collecting surface finds from the Petite Rivière site since the site was discovered. Some of these artefacts have been deposited in the depot of the Edgar Clerc Museum. Presumably, some unregistered or illegal small-scale excavation units have been made.

In 1984, a rescue excavation was executed by the French archaeologist Pierre Bodu and a few local volunteers. The aim of this excavation was to study the stratigraphy of the site and to collect a sample of archaeological material in context. In April, May and June 1984, 11 units (2x2m) were excavated, separated by 1 m wide banks that were left unexcavated in order to collect stratigraphic information (Bodu personal communication 1996). The units were located along the west-east axis of the site next to a section made by a bulldozer during contruction activities in 1983 (fig. 14, page 46). Unfortunately, no detailed excavation report with information on excavation strategy, techniques, stratigraphy and results is available. The interpretation of the remaining excavation photos is hindered because of changes that have taken place since 1984, for example by the Hugo hurricane, which passed over Guadeloupe and La Désirade in 1989 and by construction activities. The 1984 excavation resulted in the finding of an abundance of ceramics, worked shell material, flakes of flint and radiolite, animal bones, coral fragments, and two human burials. These finds were deposited in the Edgar Clerc Museum.

In 1994, the Petite Rivière site was revisited by the author to obtain an insight into the situation. The site, covered with fragments of pottery, stone, shell and coral, extended wider than previously described by Petitjean-Roget (1983), and it was threatened to be disturbed by future building activities. The regional archaeological service of Guadeloupe, in cooperation with the Archaeological Centre of Leiden University (The Netherlands), decided that it was necessary to obtain more information on this site and to study the excavated archaeological material from the

1984 units in order to prevent the further loss of contextual information from the 1984 excavations. As a result, a survey and additional shovels (50 x 50 cm test units) were executed in July 1995.

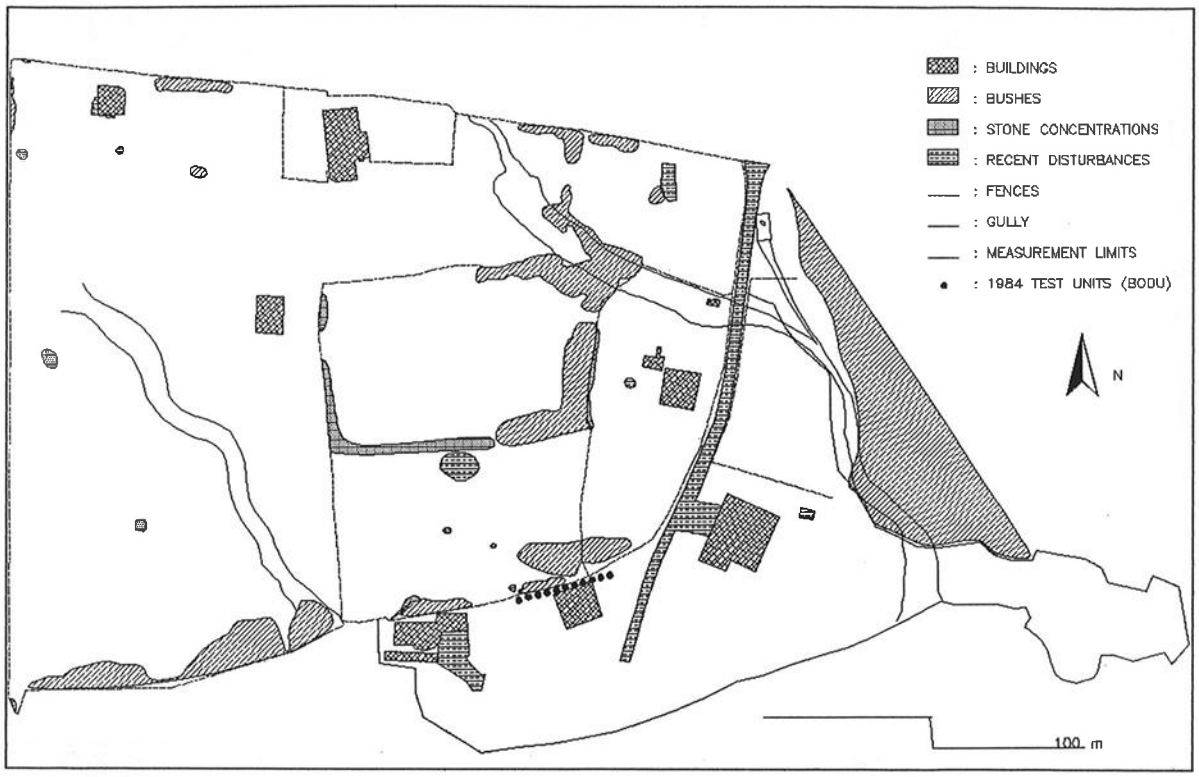


Figure 14. Location of the 1984 units at the Petite Rivière site. From left to right unit A2, B2, C2, D2, E2, F2, G2, H2, I2, J2, and K2

In 1994, the Petite Rivière site was revisited by the author to obtain an insight into the situation. The site, covered with fragments of pottery, stone, shell and coral, extended wider than previously described by Petitjean-Roget (1983), and it was threatened to be disturbed by future building activities. The regional archaeological service of Guadeloupe, in cooperation with the Archaeological Centre of Leiden University (The Netherlands), decided that it was necessary to obtain more information on this site and to study the excavated archaeological material from the 1984 units in order to prevent the further loss of contextual information from the 1984 excavations. As a result, a survey and additional shovels (50 x 50 cm test units) were executed in July 1995.

3.3 1995 FIELDWORK: THE SURVEY

3.3.1 Strategy

The survey had two objectives. First, information should be obtained on the dimensions and limits of the site. Furthermore, a topographical map should be created (fig. 15, page 48). Unfortunately, the topographical map could not be connected to the general coordinate system of the department of Guadeloupe. Therefore, fig. 16 (page 49), representing an aerial view of the Petite Rivière site, is important for the understanding of the topographical map, to which it can be easily related. Secondly, information was obtained on the distribution of archaeological material on the surface.

The visibility of archaeological material on the surface was hardly hindered because of the sparse vegetation on the site, and a surface survey could easily be executed. A systematic survey method was chosen in order to be able to make more comprehensive generalisations over the complete surface distribution. Finally, because of the limited available time and number of people, a quick coverage of the site was required.

3.3.2 Method

In order to provide a quick and systematic survey of the site, it was chosen to examine specific parts of the surface of the site, separated by systematic intervals. First, the central part of the site was measured. Its dimensions are 250 m west-east to 200 m south-north. Considering the time and number of people available, it was thought that a maximum of approximately 100 parts could be reached. Then, with an infra-red theodolite, iron pickets were placed systematically with west-east intervals of 25 m and south-north intervals of 20 m. During the survey of the site, it became clear very soon that three concentrations of surface material were present on the site. In these concentrations, pickets were placed with west-east intervals of 12.5 m and south-north intervals of 20 m, in order to provide a more precise presentation of the surface distribution. In order to standardize the areas surveyed, a large nail, which was fastened to a rope with a length of 1,13 m, was used to draw circles with a 4 m^2 surface around each picket (fig. 17, page 50). For each circle, the surface visibility was described: ground cover (percentage and type), slope, texture of soil, humidity (absent) and remarks on disturbances. Then, pottery, stone, shell, bone, coral and colonial/recent material was collected per circle. The quantities and weights of the different categories were calculated in order to make maps with the distribution for each category over the site.

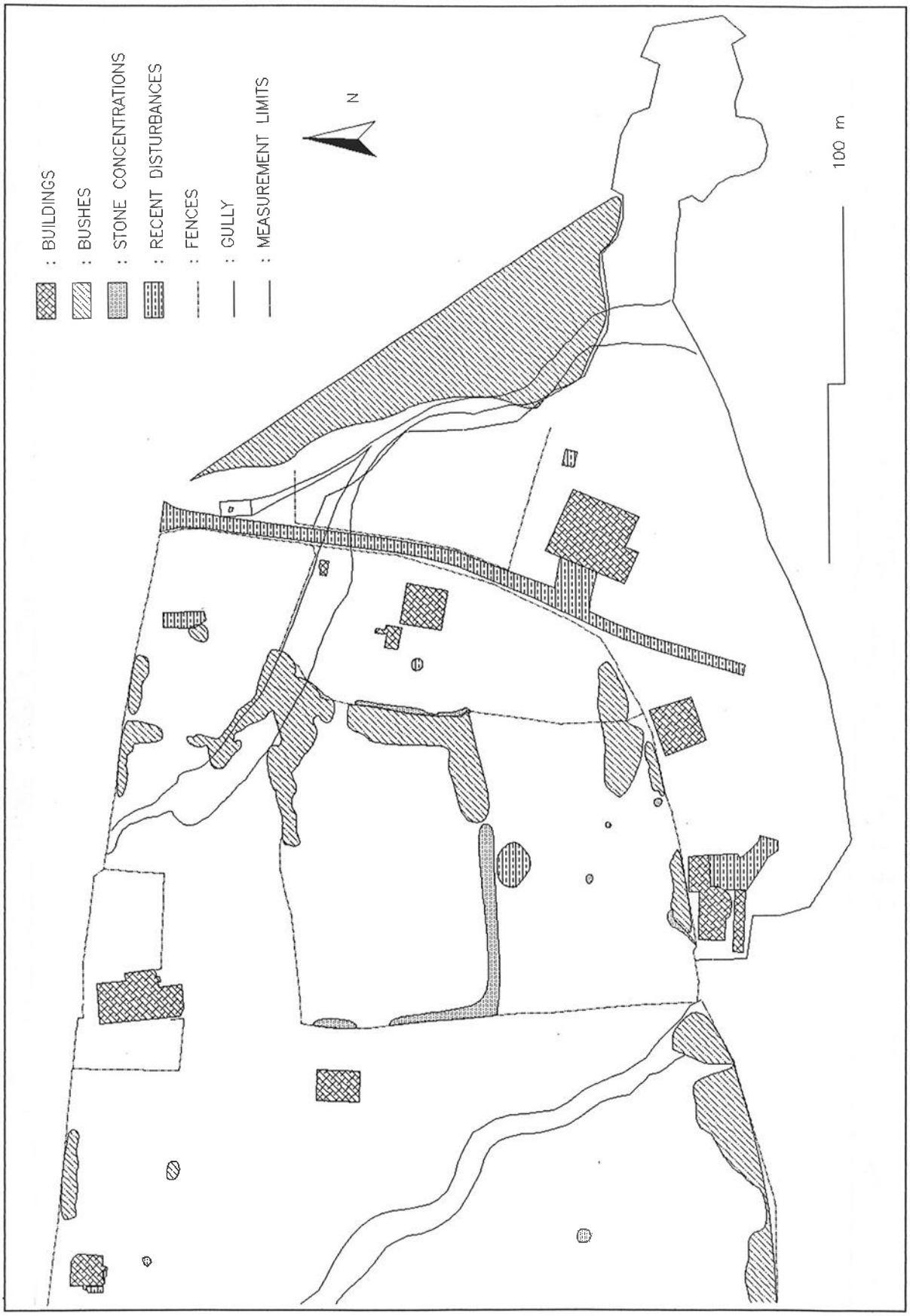

: BUILDINGS
: BUSHES
: STONE CONCENTRATIONS
: RECENT DISTURBANCES
: FENCES
: GULLY
: MEASUREMENT LIMITS
N
100 m

Figure 15 (page 48). Topographical map of the Petite Rivière site

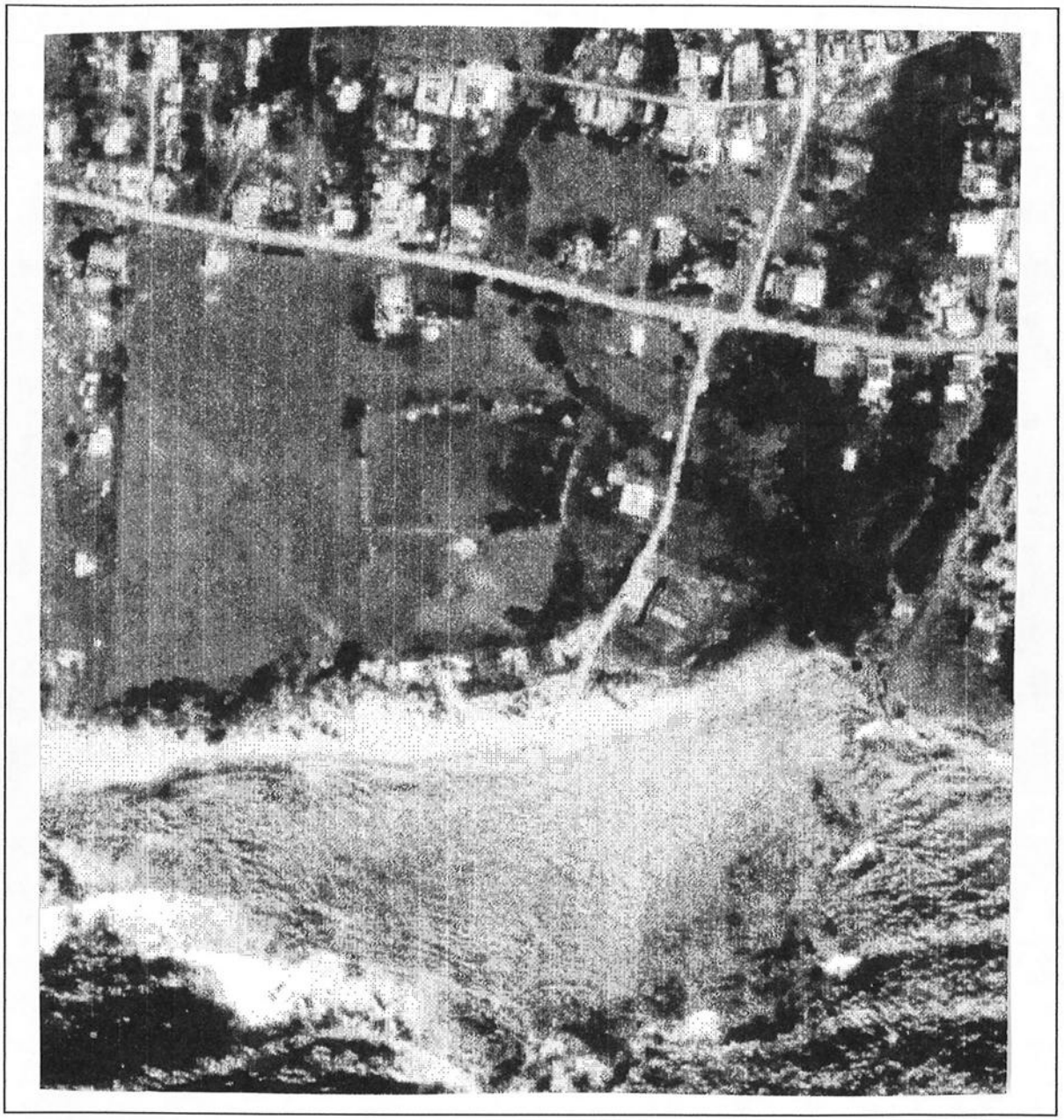


Figure 16 Aerial view of the Petite Rivière site

The weights of the different categories have not been weighed relatively because distributions per category are set out and not in comparison with other categories. Finally, the material, found during the survey, was analysed, and it was deposited in the depot of the Edgar Clerc Museum.

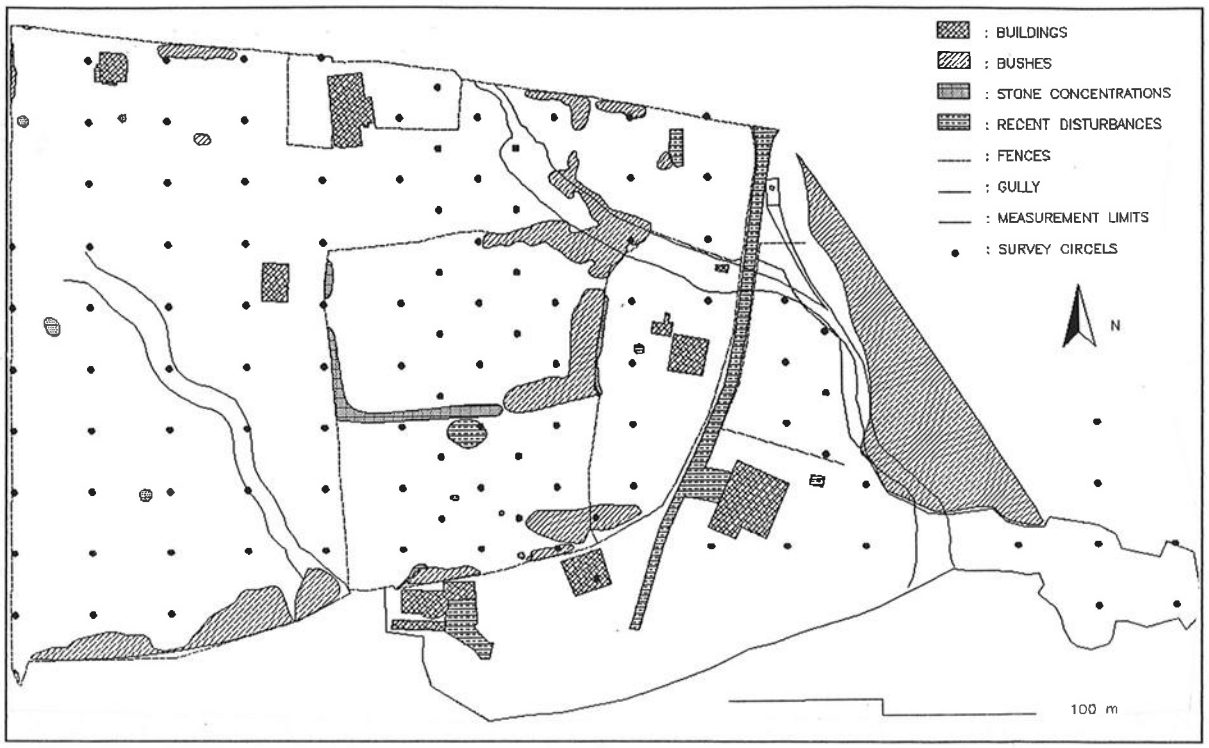


Figure 17. Circles surveyed in 1995 at Petite Rivière

3.3.3 Results

During the survey 110 circles were surveyed, of which 95 provided archaeological material, consisting of fragments of pottery, stone, shell and coral. Traditionally, dense concentrations are being interpreted as refuse areas. The distribution of the pre-Columbian surface material was used to delimit the site, where absence of surface material was taken representative to demonstrate that the limits of the pre-Columbian site had been reached. This approach, however, might exclude habitation and burial areas, which are usually less well represented by archaeological surface finds.

Three surface concentrations (fig. 18, page 51) could be distinguished. Distribution maps of the weights of pottery (fig. 19, page 51) and stone (fig. 20, page 52) show them most clearly. One is to be found in the enclosure of fences on the central part of the site, a smaller concentration is enclosed by the road to the beach and the eastern gully in a worked garden and the third on an elevated plateau at the easternmost part of the site. Shell (fig. 21, page 52) and coral material (fig. 22, page 53) is more dispersed over the site, and especially dense in the western part of the site. Still, the densest distributions of these categories fall together with the three main concentrations. Further dispersion of shell and coral material can be explained by colonial or present distribution of these naturally occurring materials. As for the colonial material, weight distributions are modest over the central part, and non-existent for the eastern part of the site (fig. 23, page 53).

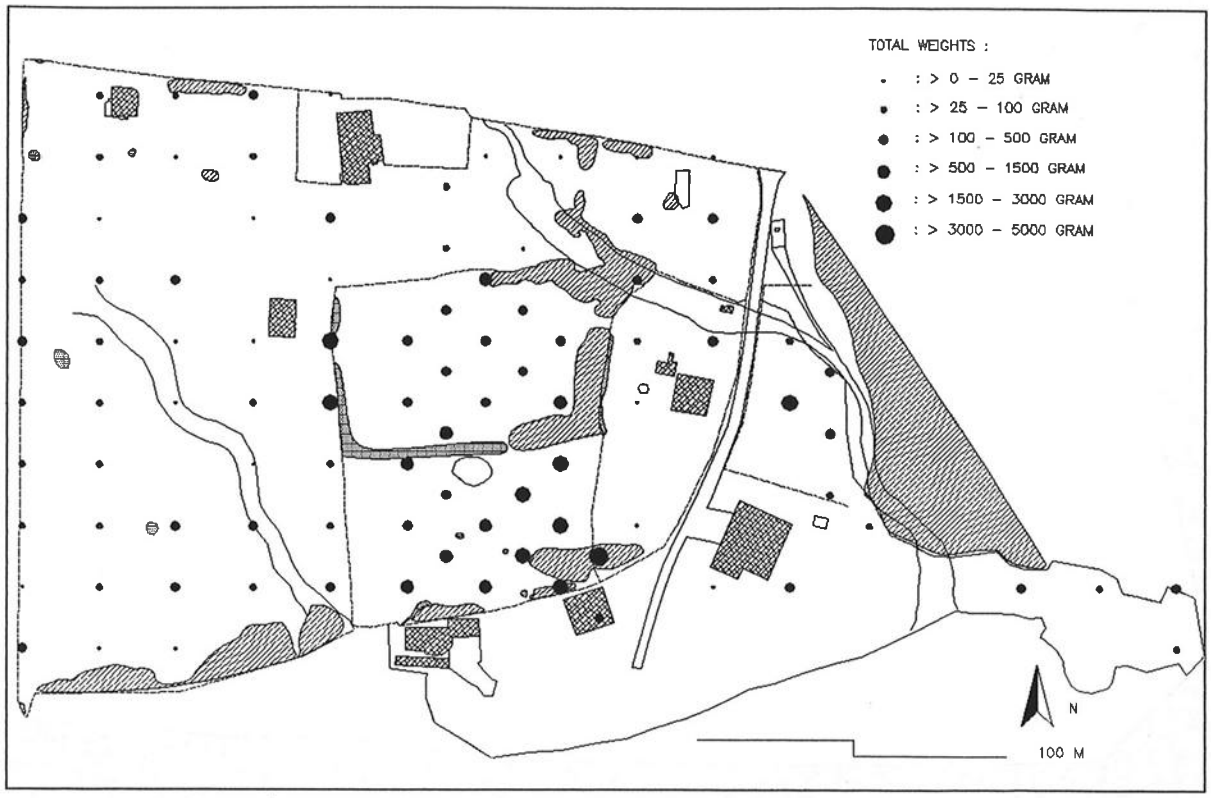


Figure 18. Total artefact weight (g) found during the 1995 survey at Petite Rivière

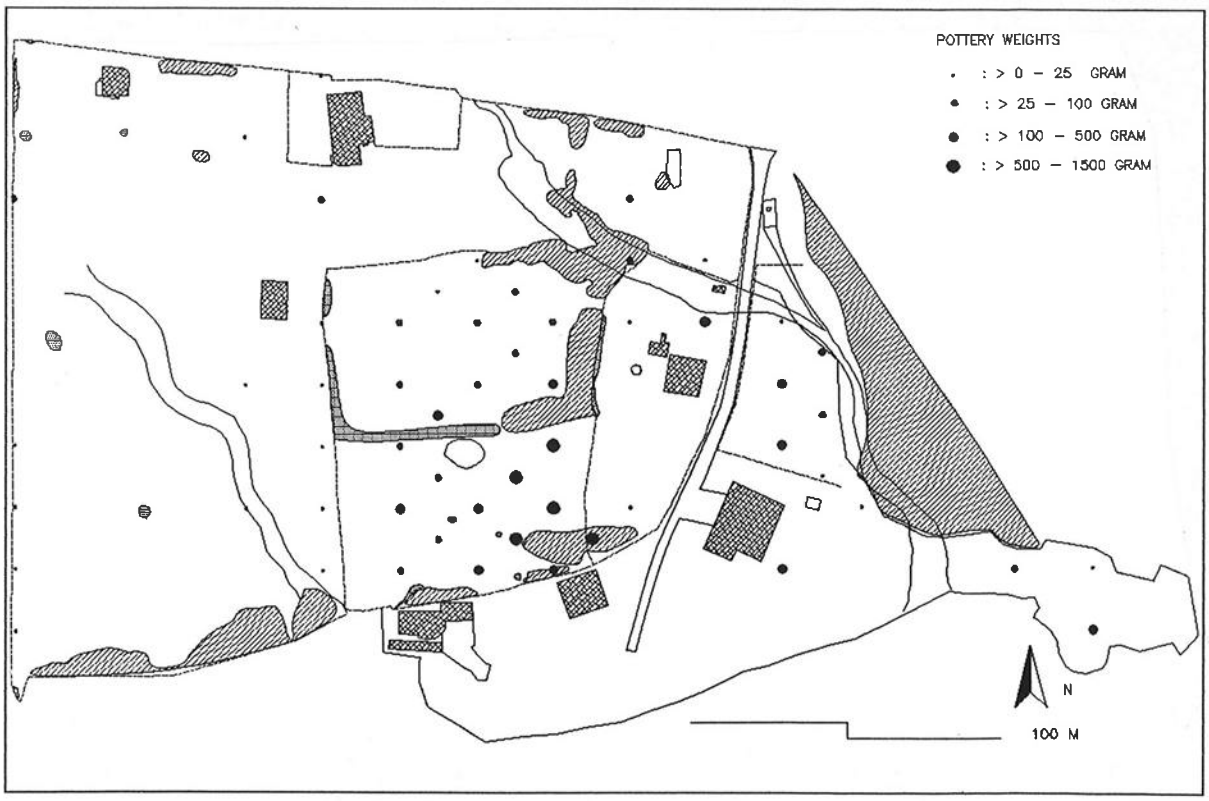


Figure 19. Petite Rivière pottery weight (g) found during the 1995 survey

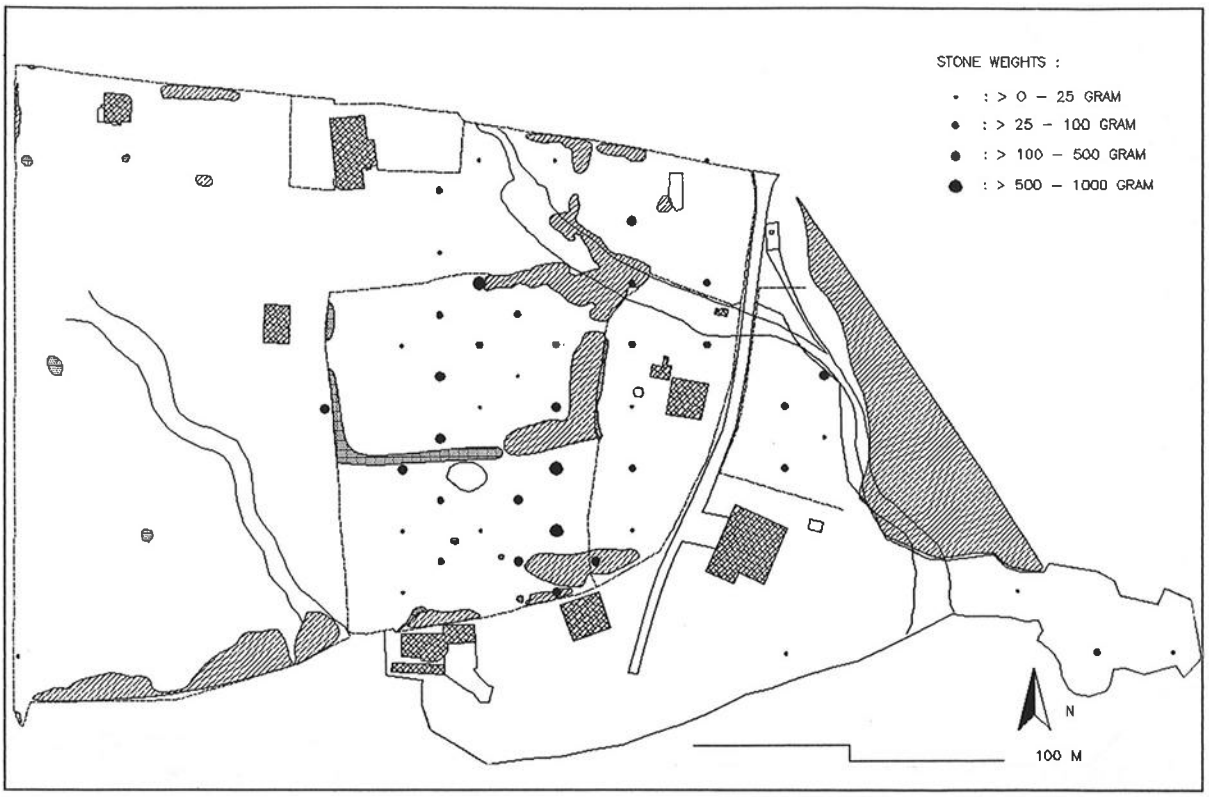


Figure 20. Petite Rivière stone weight (g) found during the 1995 survey

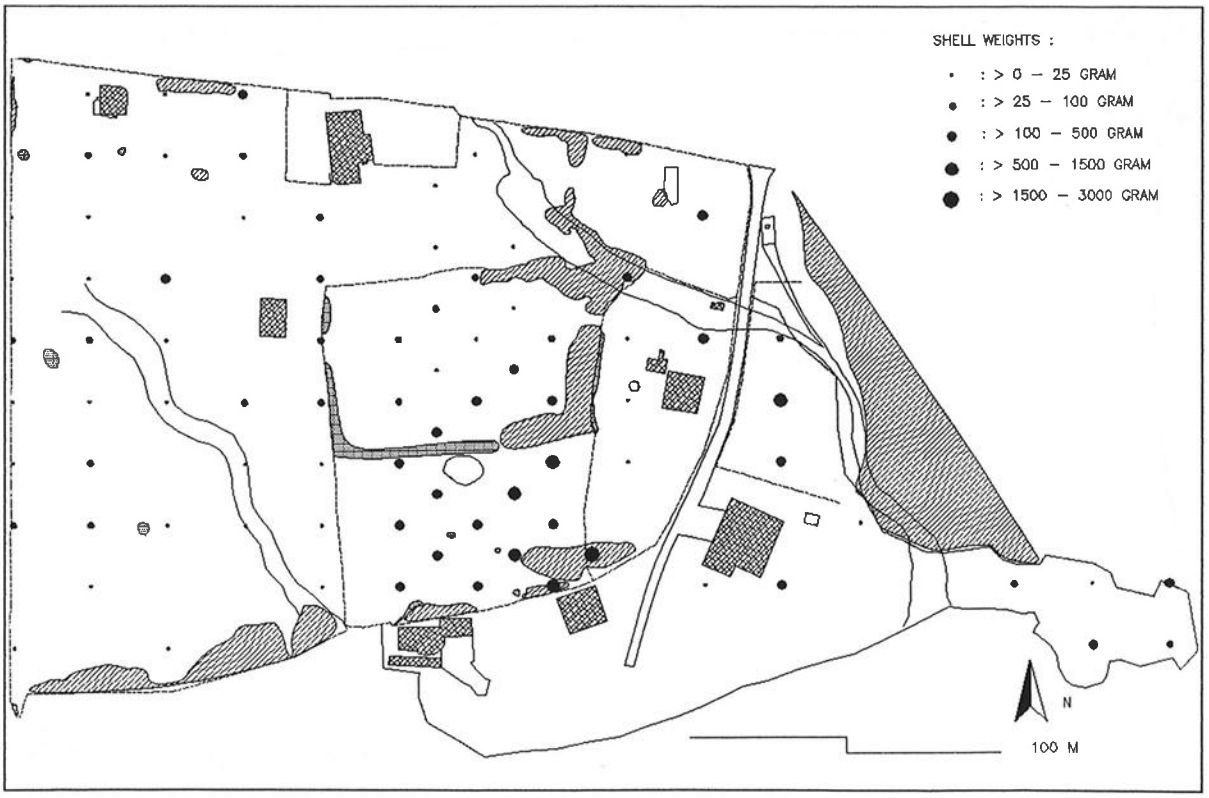


Figure 21. Petite Rivière shell weight (g) found during the 1995 survey

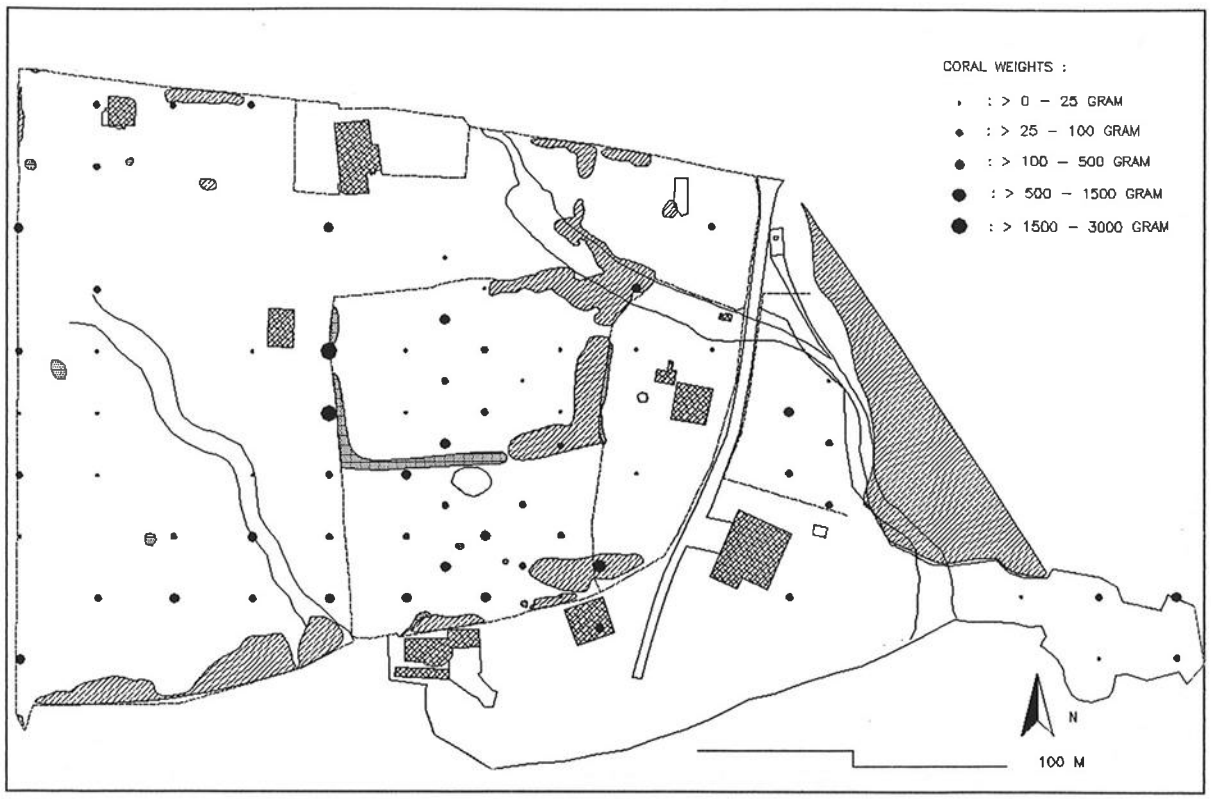


Figure 22. Petite Rivière coral weight (g) found during the 1995 survey

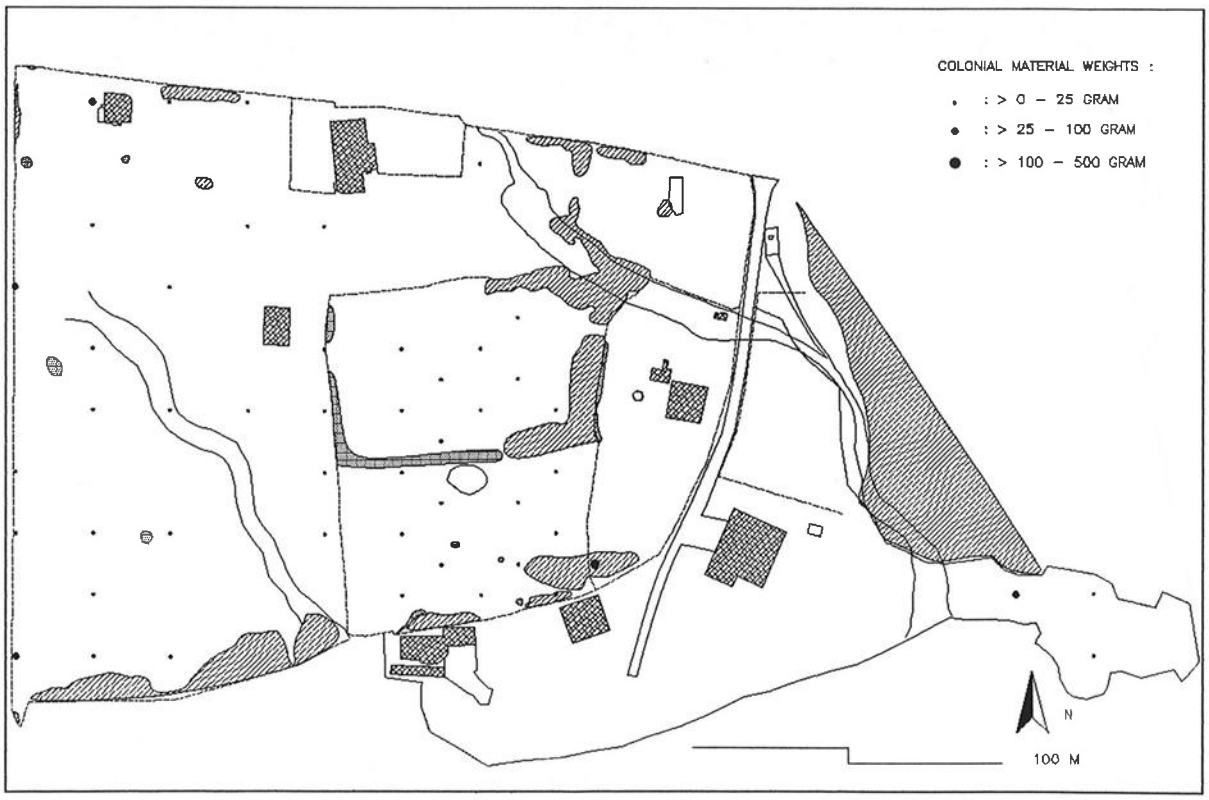


Figure 23. Petite Rivière colonial material weight (g) found during the 1995 survey

As natural factors might influence the artefact distribution over the surface of the site, data on ground cover percentages, ground cover types, slope and texture of soil were collected in the field. The *ground cover percentages* (table 1) were rather low in general. In the western part of the site, the percentages hardly exceeded 5%. In the east part of the site the ground cover became denser and here the percentages ranged between 60 and 100%. The different ground cover percentages do not seem to have influenced the amounts of artefacts and ecofacts gathered from the surface. The westernmost part of the site yielded hardly any finds, although ground cover percentages ranged from 0 to 5% here, and although most of this ground cover consisted of low grass.

ground cover %	score %
≥ 0 - 25%	59.3
> 25 - 50%	19.1
> 50 - 75%	9.0
> 75-100%	12.6

Table 1. Ground cover percentages of the Petite Rivière site

The *ground cover types* (table 2) represent an open vegetation. On the western part of the site the vegetation consists of low grass, on the central part high grass and shrubs or weeds appear and on the eastern part cultivated plants and trees cover the surface. Of these ground cover types only the latter seem to have influenced the visibility of artefacts, because their cultivation caused disturbance of the archaeological layer.

ground cover type	occurrence %	ground cover type	occurrence %
low grass	64.6	weeds	2.7
high grass	5.5	cultivated plants	2.7
grass and shrub	6.4	trees	2.7
grass and weeds	10.9	sand	1.8
shrub	2.7		

Table 2. Ground cover types of the Petite Rivière site

As for the *slope* (fig. 24, page 56), the terrain is smoothly descending from the northwest part of the site towards the beach. Steeper slopes are to be found in the gully that results from the Petite Rivière source, and at the southern part of the site where three-pointed contourlines reflect a steep rocky descent, between the site and the beach. West of this descent, a steep slope divides the beach from the intermediary plateau, and a second, more modest slope divides this plateau from the site.

Surprisingly, hardly any surface finds were made in the gullies, where denser artefact concentrations could be expected because of erosion from higher parts of the site. The steep slopes between the three levels greatly influenced the find distribution and was also badly aggravated by the destructive building activities which took place at that part of the site. Since the site was so badly disturbed here, the slope between the site level and the intermediary plateau was taken to be the limit of the surface survey. In general, no great influences because of the slopes on surface distribution could be demonstrated and they are not likely to have occurred.

The *texture of the soil* (table 3) consists on the western part of the site of gravel in a clay matrix, on the central part of gravel in a sand matrix and on the eastern part a clay matrix with humic elements is to be found. A rather loose sand matrix is often associated with recently brought up sand for constructions (beach sand), although on the central part of the site sandy matrices occur naturally. In the field, the soil texture appeared to have had no influence on artefact concentrations and their visibility.

texture of soil	occurring %
gravel in clay matrix	60.9
clayish matrix	18.2
gravel in sand matrix	3.6
sandy matrix	17.3

Table 3. Texture of the soil at the Petite Rivière site

3.3.4 Conclusions

Based on the data from the survey, the Petite Rivière site seems to be a large (± 250 x ± 200 m) pre-Columbian coastal site which refuse area is represented by three patchy surface concentrations. It was decided to execute some additional test pits.

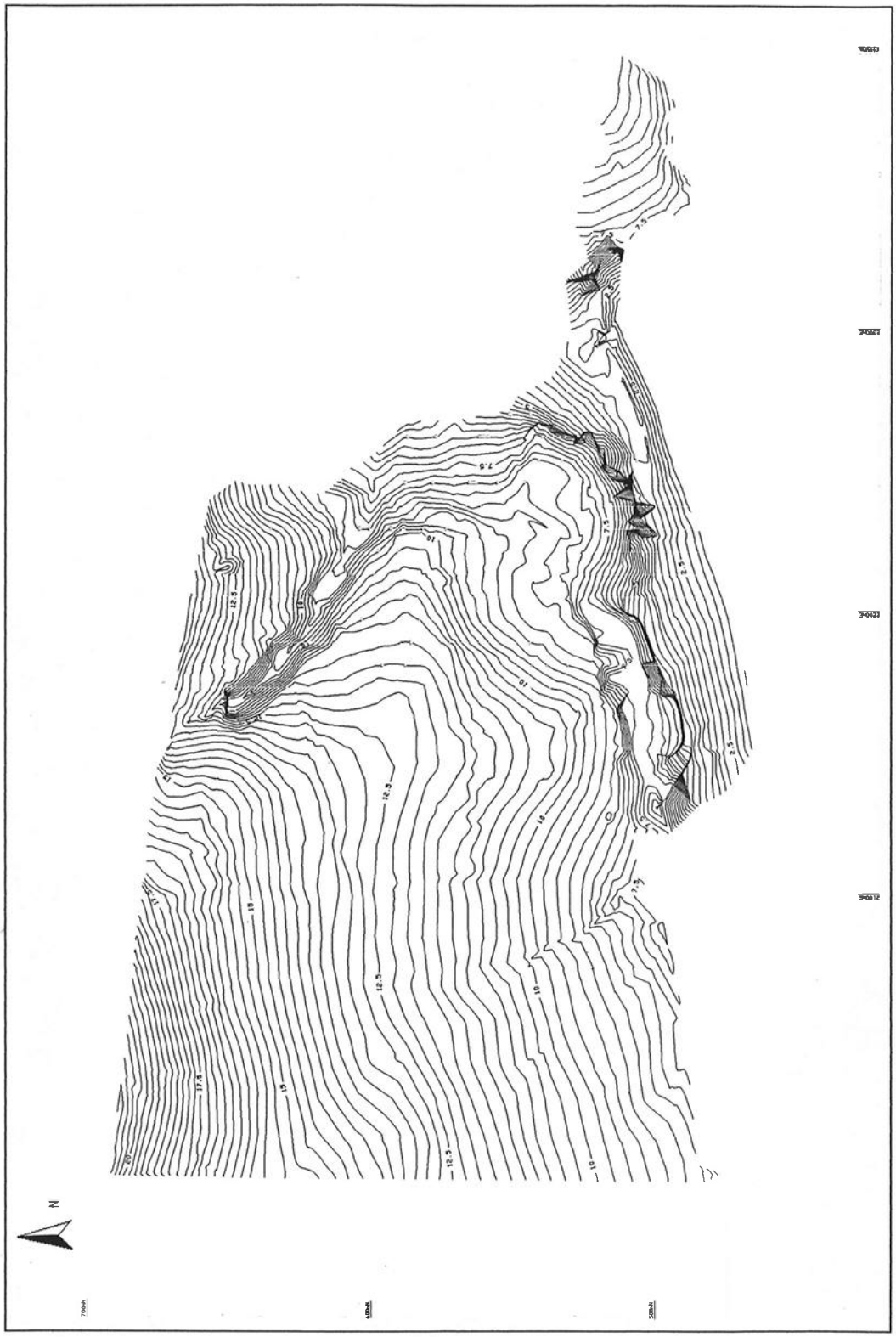


Figure 24 .Contour map of the Petite Rivière site

3.4 1995 FIELDWORK: THE TEST UNITS

3.4.1 Strategy

Additional test pits were made in order to provide a better general, contextual understanding of the site. The excavation had three objectives. First, the geological and archaeological stratigraphy of the site should be studied. Secondly, a sample of diagnostic archaeological material should be obtained in context. It should then be tried to get an insight in the context of the archaeological material from the 1984 excavations. In order to complete the information on the site, a contour map (fig. 24) was made with an infra-red theodolite.

3.4.2 Method

For a better understanding of the site, small but dispersed shovels were preferable. A total of 13 shovels (50x50 cm) were made. The dimensions were limited by the time and number of participants, the attempt to limit the destruction of the terrain and the very hard and compact clay soil. The shovels were excavated per stratigraphic layer. Shovels 1-7 were excavated into the bedrock. As the stratigraphy of those shovels was simple and without variation, it was decided to excavate shovel 8-13 into sterile layers and to use an auger with a diameter of 10 cm to reach the bedrock. All the material that was excavated from the shovels was wet-sieved in the sea on a 2.8 mm mesh sieve, a time and energy consuming process. One shovel, however, was wet-sieved on a 2 mm mesh sieve in order to obtain an accurate sample of faunal remains. The archaeological material was then washed if necessary, dried, labelled and put in bags. Finally, when each shovel was finished, photos and drawings of their sections were made.

3.4.3 Location of the test units

The first shovels were located in the concentrations at the surface to see whether the surface concentrations corresponded with the vertical distributions. Shovels 1, 2 and 3 were made on the central part of the site, shovels 5 and 6 on the elevated plateau at the eastern part of the site (shovel 5 was not finished because of recent disturbances) and shovel 7 in the worked garden. Shovels 8 and 9 were made to delimit the richer archaeological area, which was closest to the 1984 test units.

In this area, shovels 4, 10, 11, 12 and 13 were made adjacent to shovel 1, in order to create a stratigraphic section of 1 x 1.5 m and to collect a sample of archaeological material (fig. 25).

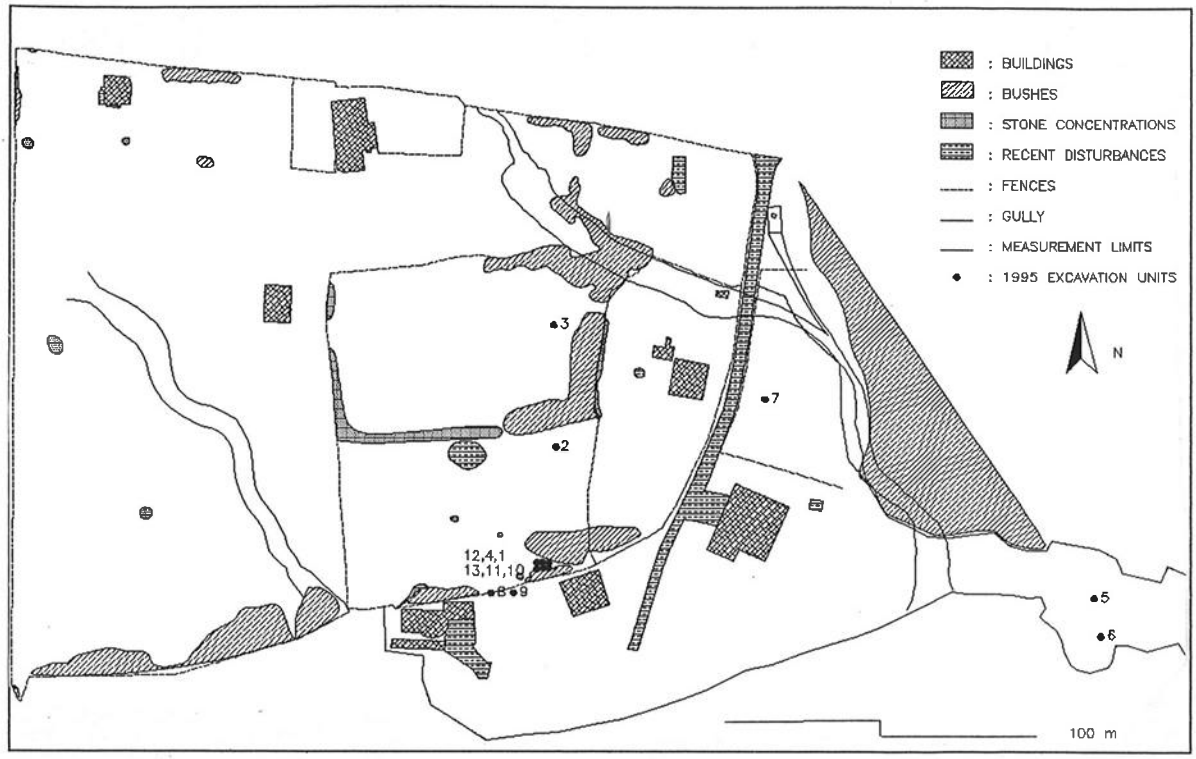


Figure 25. Location of the 1995 test units

3.4.4 Stratigraphy of the site

Sections, providing characteristics of the stratigraphy of the site, were obtained from the shovels. In general, it was uncomplicated and the sequence of the strata was the same in all the shovels (fig. 26, page 59). The first 15-34 cm consisted of a compact and dry clay, containing the artefact concentration. The next stratum with a thickness varying between 4 and 28 cm consisted of a very compact clay layer with a modest artefact concentration, separated from the substratum by a very compact layer without finds and with thicknesses varying between 2 and 20 cm.

During the excavation it became clear that the topsoil had been rooted up superficially by agricultural activities on the site. Although only one layer with archaeological material was discovered, Late Saladoid as well as post-Saladoid ceramics were found. As this pottery appeared to be rather mixed up in the upper layer, it has been impossible to distinguish different occupation levels during the 1984 excavations (Bodu personal communication 1996) and the 1995 fieldwork.

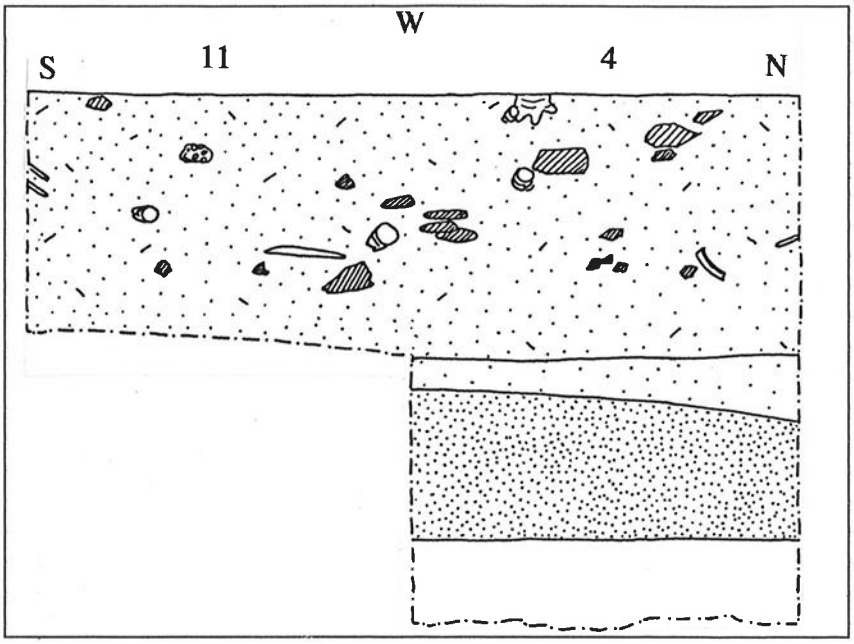


Figure 26. West sections of shovels 11 and 4 (scale 1:10)

Worked topsoil, consisting of compact, dry clay, with the artefact concentration. Colour: dark reddish brown (5YR,3/2)[36]

Very compact clay layer, with a modest artefact concentration. Colour: dark reddish brown (2.5YR,3/3)

Compact clayish lens. Colour: pinkish grey (5YR,6/2)

Very compact clay layer, with chalk fragments from the bedrock, without finds. Colour: weak red (2.5YR,4/2)

Bedrock, consisting of compact chalk, without artefacts. Colour: pinkish grey (5YR,8/2)

Pottery

Stone

Shell (*Cittarium pica*)

Shell (*Strombus gigas*)

Coral

3.4.5 Post-depositional Processes

Some stratigraphic sections of the Petite Rivière site show features that might be explained as the results of cultural or natural (chemical, biotic, climatological, and geological) processes that took place after the initial formation of the site. These post-depositional processes (Schiffer 1987), cause deformations within the site.

Cultural influences involve the deliberate or accidental activities of human beings (Renfrew and Bahn 1991:44). At the Petite Rivière site they involve the later occupation of the site, the cultivation of cotton, small-scale agricultural activities in pre-Columbian, colonial and recent times and recent constructions. The features caused by these activities contain regularly formed depressions

[37] Munsel Soil Color Chart.

like postholes, storage pits and ditches, and the post-depositional dispersion of artefacts especially over the surface of the site and through the different layers. Natural transforms are the chemical, biotic, climatological, and geological processes that govern both the burial and the survival of the archaeological record (Renfrew and Bahn 1991:44). Features caused by these processes contain often irregularly formed depressions and the post-depositional dispersion of artefacts especially through the different layers.

Some of the Petite Rivière sections contain features that might be explained as being the results of post-depositional processes. Stratigraphic information suggests that they probably took place in pre-Columbian times. The north section of shovel 2 (fig. 27a, page 61), for example, first contains a line of stones, which shows up at 24 - 33 cm. It is also characterized by a shallow but extended depression from 33 - 49 cm. Human activities could not be demonstrated to have caused these features. Furthermore, the east section of shovel 2, shows a shallow but extended depression, for which human influences could not be demonstrated either. To finish the description of the features of shovel 2, it should be mentioned that the south section of this shovel shows a lens of pinkish grey (5YR,6/2) compact clay at 17 - 23 cm, and a shallow deepening from 23 - 25 cm, which is probably natural. Human influences could not be demonstrated either to have caused the north section of shovel 1 (fig. 27b, page 61), which shows an even deepening which descends from 33 - 49 cm. The south section of this shovel (fig. 27c, page 61), however, shows a deepening from 32 - 51 cm, followed by a deepening in the upper stratum, which diminishes obliquely through the shovel. Those features seem to be too abrupt to be natural deepenings.

3.4.6 Results

For the 1995 project, small but dispersed shovels were executed to examine the vertical distribution in comparison with the horizontal distribution. A larger-scale and more time-consuming excavation (also in low density areas) might have revealed more information on patterns and structures within the site, but this was impossible within the scope and the timetable of this project.

The contents of shovels 2, 3, 5, 6, 7, 8 and 9 did not correspond with the promising artefact density on the surface. As for shovel 7, this could be explained by agricultural activities. Shovels 5 and 6 showed that the east plateau had been recently disturbed. Neighbours declared that this part of the site had a rich surface concentration of pottery fragments before a bulldozer smoothed the terrain. The largest part of the site is represented by a thin and disturbed archaeological layer, due to cultural influences as described above.

Shovels 1, 4, 10, 11, 12 and 13 contained more archaeological material, with Late Saladoid and post-Saladoid ceramics among other find categories. The stratigraphic sequence of these shovels resembled that of the 1984 units (Bodu personal communication 1996). This part of the site belongs probably to the margins of the refuse midden, in which the 1984 test units were situated.

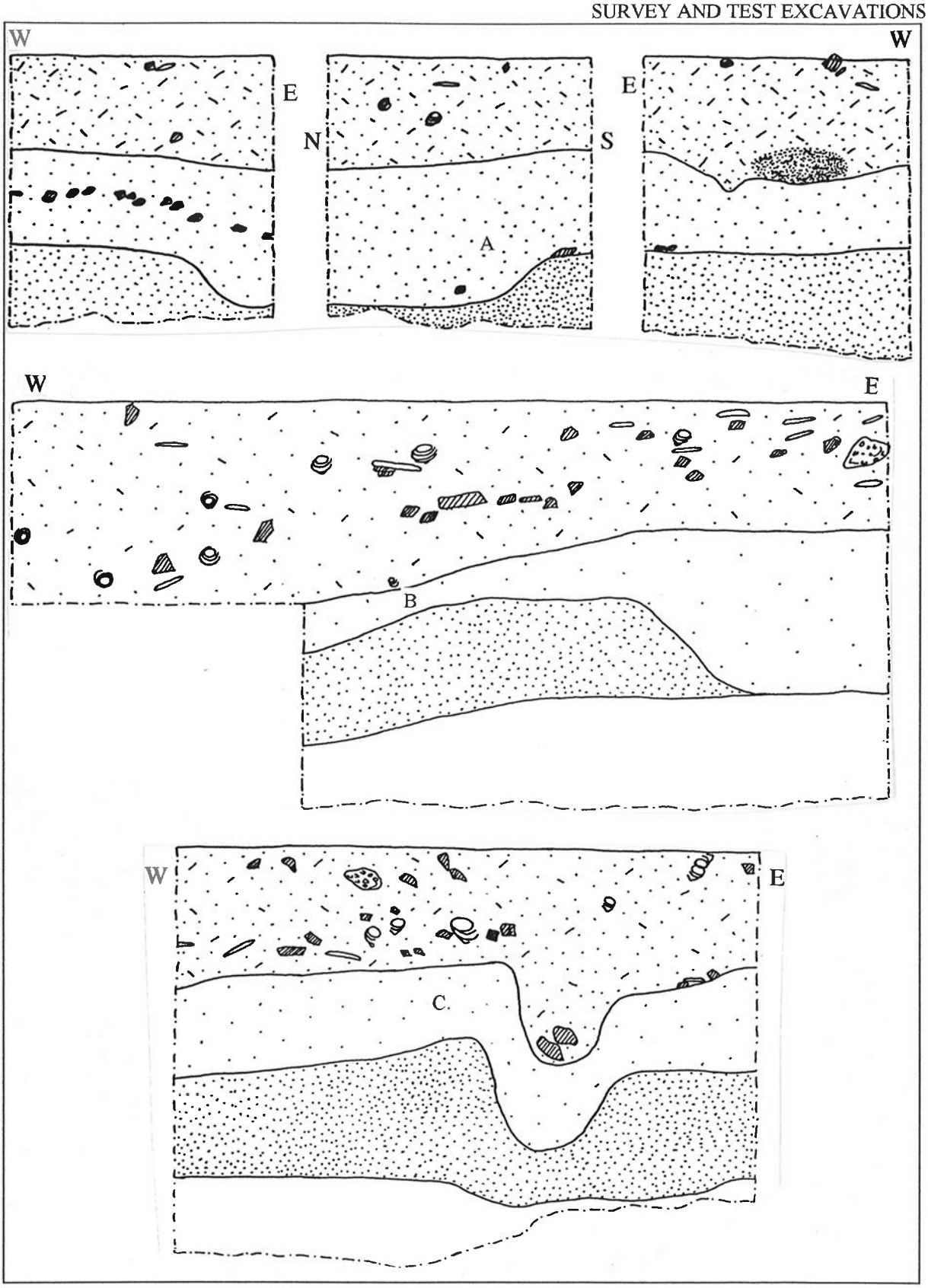


Figure 27. Stratigraphic sections (scale 1:10): A. north, east and south sections of shovel 2; B. north sections of shovels 12, 4 and 1; C. south sections of shovels 4 and 1

During the excavation, the archaeological sequence of shovels 1, 4, 10, 11, 12 and 13 proved to be disturbed. Post-Saladoid pottery was often found below Late Saladoid pottery. Probably, this can be caused by a slow geological sedimentation and post-depositional processes during different periods in prehistory, colonial, and recent times. The slow sedimentation process is shown in the archaeological layers (in general 15 to 34 cm thick) in the stratigraphic sections, whereas the Late Saladoid and the post-Saladoid pottery indicate a sedimentation period of approximately 300 to 500 years. Post-depositional processes as digging ditches and postholes, and the vertical movement of artefacts through the layers by trampling of humans and animals living on the site cause further displacement of artefacts.

Probably, the most important part of the site has been destroyed by construction activities, when 15-20 Amerindian burials were found and removed according to neighbours. Thus, the present site of Petite Rivière is probably not representative for the site as it may have been in pre-Columbian times.

3.4.7 Radiocarbon dates (table 4, page 63)

Two unmodified *Cittarium pica* shell samples were obtained from the 1984 test units, from level 0-10 cm in unit A2, and from level 25-35 cm in unit C2 (fig. 14). An other *Cittarium pica* sample was obtained from the archaeological level of shovel 13 during the 1995 fieldwork (fig. 25, page 58). These samples were obtained from units that were situated very near to each other and from the same archaeological level. They were sent to the Laboratory for Isotopic Research in Groningen (The Netherlands). The BP dates have been calibrated with the Groningen calibration programme CAL 15 using the calibration curve for marine shell[37]. The calibrated radiocarbon dates with a 68.3% security level suggest that the site was at least occupied between 600-652 cal AD, between 1012-1042, 1096-1114, and/or 1144-1154 cal AD, and between 1312-1350, and/or 1390-1402 cal AD.

[37] Stuiver and Braziunas 1993.

Provenance (unit, level)	Number	Material	BP date[38]	cal AD (95.4%)	cal AD (68.3%)
C2, 25-35 cm	GrN-20878	*Cittarium pica*	1440 ± 35	554-580 590-662	600-652
13, 0-30 cm	GrN-22114	*Cittarium pica*	990 ± 30	998-1060 1076-1124 1134-1160	1012-1042 1096-1114 1144-1154
A2, 0-10 cm	GrN-20877	*Cittarium pica*	595 ± 30	1302-1366 1376-1412	1312-1350 1390-1402

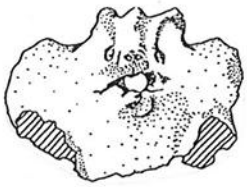
Table 4. Petite Rivière radiocarbon dates

3.5 CONCLUSION

The Petite Rivière site must have been an important pre-Columbian coastal settlement, with a possible occupation area at the southern coastal plain, a considerable refuse-area and a large burial area. Nowadays, the site is represented by a thin artefact layer which is distributed over almost the whole site. The surface is disturbed due to agricultural activities. Important parts like refuse area and burial area have been destroyed by bulldozer groundworks. The measures for protection as proposed by Petitjean-Roget (1983:7-9) did not achieve the preservation of the most important parts of the site.

Indications for human occupation in the form of pre-Columbian postholes and house structures were not found during the 1995 project. Those might be found on the extended flat terrain north of the debris zone and information on this might be revealed by larger-scale excavations. Permanent pre-Columbian occupation of the site seems to be possible due to the various exploitable resources on and around the island of La Désirade. Furthermore, the archaeological material and the presence of an extended refuse area and burial area do not suggest temporary occupation in the form of a non-permanent special activity or a resource extraction site.

[38] Substraction of 400 years has taken place in order to cope with the reservoir effect.



4 ARCHAEOLOGICAL MATERIALS

4.1 INTRODUCTION

In this chapter, the archaeological materials that were found during the 1984 and 1995 fieldwork at the Petite Rivière site are described as part of the excavation report of the Petite Rivière site. This was done for the 'Direction Régionale des Affaires Culturelles' (D.R.A.C.) of Guadeloupe in order to provide a contribution to the realisation of the archaeological map of Guadeloupe and its annexes. The 1995 fieldwork had taken place within this framework. Not all of the materials do provide information on pre-Columbian subsistence and diet. The excavated materials include pottery, stone artefacts, shell food remains and shell artefacts, coral fragments and coral artefacts, faunal remains, and human skeletal remains. The materials that do provide information on pre-Columbian subsistence and diet will be studied in more detail in chapter 5. Archaeological materials from the 1995 and/or 1984 excavations were included in the analysis, depending on the quality and quantity of the material per category. Since the 1984 units were situated next to each other, the material they provided could easily be studied as a whole. Their position related to the archaeological midden may explain the differences in the quantities of their material. Unit F2 contained most material as it must have been situated in the densest part of the midden. The excavated materials from the 1995 units were also considered as a whole, as they originate from different concentrations belonging to the same site, that were separated as a result of recent disturbances. Units 1, 4, 10, 11, 12, and 13 provided most excavated material as they were situated next to the 1984 units and near the midden. Differences in quantity of material may also be explained through different densities of the midden. Units 2, 3, 6, 7, 8, and 9 contained less material as they were more removed from the midden, but they are included in the analysis as they belong to the same site and the same archaeological context. Unit 5 was excluded from all analyses as it appeared to have been recently disturbed. The materials that were included in the different analyses were washed, dried, bagged and labelled, and sent to the Netherlands, where they were studied in the laboratories of Leiden University[39]. The data were processed in DBase IV and Harvard Graphics. The other materials were stored in the depot of the archaeological Edgar Clerc Museum in Le Moule (Guadeloupe).

---

39 After the analyses, the material will be sent to the archaeological museum on Guadeloupe.

4.2 POTTERY

4.2.1 Provenance of the pottery

Pottery excavated during the 1984 and 1995 excavation campaigns was included in the analysis[40]. The 1984 material was dry-sieved on 5 mm mesh sieves. Most of the pottery was found in unit F2, which produced 56.3% of the excavated pottery in 1984 (fig. 28, table 5). A sample of the 1984 pottery was studied. The pottery of the 1984 units B2, D2, F2, H2, and J2 (fig.14, page 46) was studied in detail and subjected to a fitting session. The pottery of units A2, C2, E2, G2, I2, and K2 was only used to investigate special, additional pottery characteristics that had not been found in the other units.

The material from the 1995 units (fig.25, page 58) was wet-sieved over 2.8 and 2.0 mm mesh sieves, and afterwards dry-sieved over a 5.6 mm mesh sieve in order to obtain a determinable sample of pottery, which was also subjected to a fitting session. Most of the pottery was found in units 1, 4, and 13, unit 1 being the most prominently represented (fig. 29, table 6).

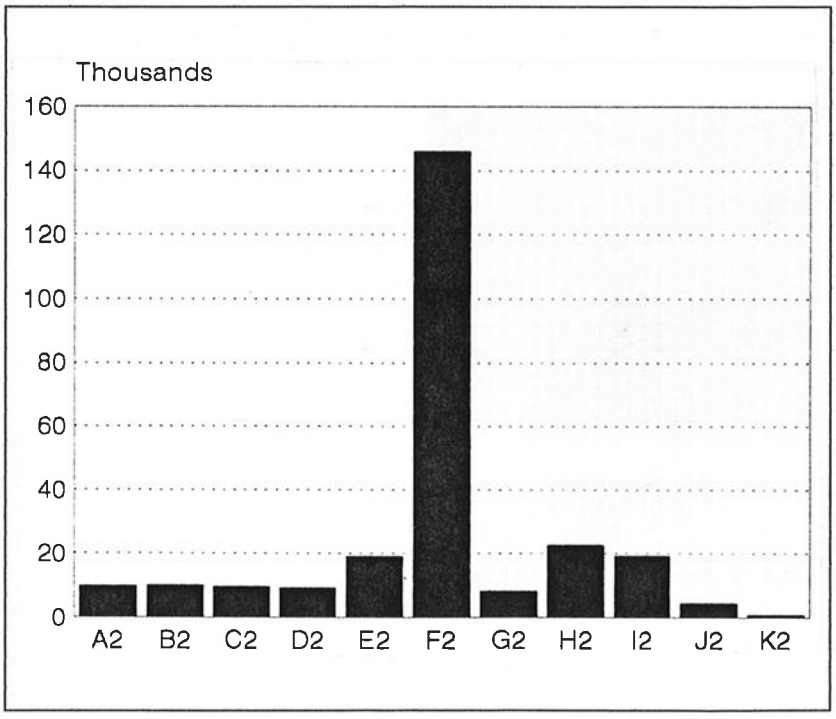


Figure 28 .Petite Rivière pottery weight (g) per 1984 unit

40 More detailed information on the 1984 and 1995 excavations can be found in chapter 3.

unit	weight (g)	%	unit	weight (g)	%
A2	9841	3.8	G2	8199	3.2
B2	10010	3.9	H2	22717	8.8
C2	9739	3.8	I2	19190	7.4
D2	9304	3.5	J2	4373	1.7
E2	19026	7.3	K2	808	0.3
F2	146017	56.3	total	259224	100.0

Table 5. Petite Rivière pottery from the 1984 excavations

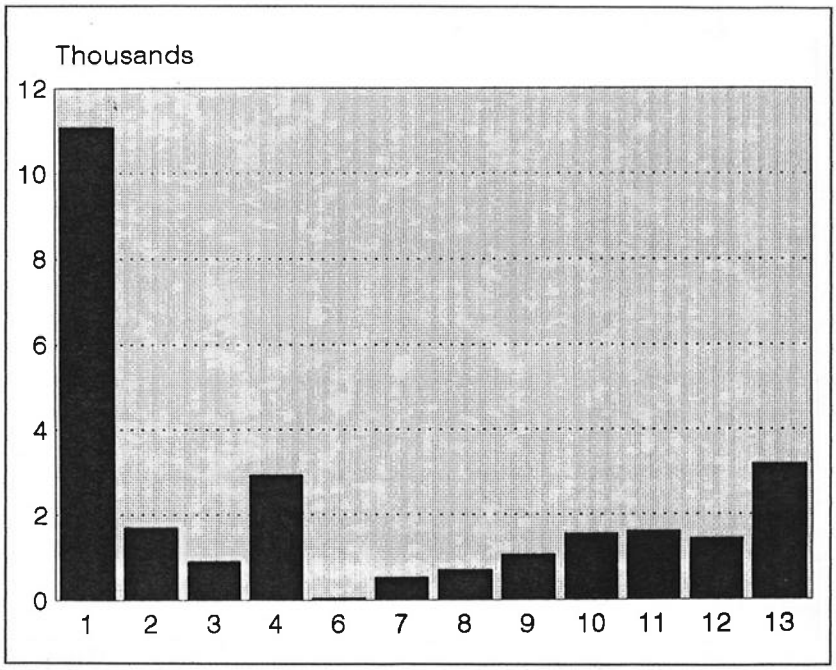


Figure 29. Petite Rivière pottery weight (g) per 1995 unit

unit	weight (g)	%	unit	weight (g)	%
1	11079	41.4	9	1066	4.0
2	1709	6.4	10	1553	5.8
3	924	3.5	11	1618	6.0
4	2931	10.8	12	1448	5.4
6	40	0.2	13	3187	11.8
7	524	2.0	total	26789	100.0
8	710	2.7			

Table 6. Petite Rivière pottery from the 1995 units

4.2.2 Description and analysis of the pottery

The interest of Caribbean archaeologists has been focused traditionally on the description and regional chronological classification on the basis of shapes, rimprofiles, and decorations[41] of pottery. Different schemes have been proposed for the classification of post-Saladoid pottery. Allaire (1977), for example, has set up a classification for the post-Saladoid decorated pottery on Martinique on the basis of vessel shape and decoration modes. An other example is the classification of Goodwin (1979), that is based on different clay and temper classes for Saladoid and post-Saladoid material. He had to conclude, however, that his classification was too ambiguous and subjective (Hofman 1993:53-54). As for more descriptive reports, those of McKusick (1960), Bullen (1964, 1970), Bullen and Bullen (1970), Bullen et al. (1973), Allaire (1977; 1992), Harris (1991[a]; 1991[b]), and Hofman (1995[a]) are among the best known.

The objective for the pottery analysis presented here was to get an insight in the Petite Rivière pottery and in its place in the cultural chronological framework. It is an "analysis of stylistic and morphological features of the pottery" as proposed by Hofman (1993:55). Detailed technological or functional information was not obtained, and quantitative analyses could not be executed as a result of the incomplete nature of the studied sample. In order to standardize the recording of the different stylistic and morphological characteristics of the pottery, a description form, that has been designed by Hofman (1993) for the study of Saban pottery assemblages, was used. The form consists of two pages. On the first page, the numbers and weights of sherds of respectively bodies, rims, bases, griddles, and appendages or other categories are recorded. It is also recorded how many sherds of these different categories are smaller or larger than 5 cm. Then, the number of sherds finished with a red or beige slip or paint, and the number of sherds representing different decoration modes can be recorded. Finally, special attention is paid to the number of different base shapes and griddle rim shapes represented, and the number of appendages or other pottery items in the sample. On the second page of the form, the rims larger than 5 cm are studied and their characteristics, concerning vessel shape, wallprofile, lipshape, rimprofile, wall thickness, orifice diameter and its percentage represented, decoration, munsell chart colours, firing atmosphere, surface finishing, and the presence of red slip, are coded.

[41] Goodwin (1979:232) argues that the analysis of only decorated sherds might not be representative, as decorated pottery might belong to a limited social group or reflect special occasions.

4.2.3 Results of the pottery analysis

4.2.3.1 Introduction

A total number of 8940 sherds was analysed, representing a weight of 286 kg. The fragmentation of the pottery is modest, considering that the average sherd weighs 32 g. It should be noticed, however, that the majority of sherds (62.7%) is smaller than 5 cm (table 7, page 70). These small sherds are mainly found in the body sherd category, while in the other categories the majority of sherds is larger than 5 cm. The sherds measure 5.6 mm at least, since all the excavated material has been sieved over 5.6 mm mesh sieves in the laboratories of Leiden University.

4.2.3.2 General pottery characteristics

The Petite Rivière pottery consists of a very small Late Saladoid component and a large post-Saladoid component. Unfortunately, the pottery from both periods appeared in the units in one layer and completely mixed up. A total of 12 sherds, decorated by fine incision, and two rims could be attributed to Late Saladoid pottery. This is only 0.2% of the total sample. The main part of the pottery appeared to be post-Saladoid. The study of post-Saladoid pottery is often problematic. In this period, local developments influenced the pottery, and only a minor part of the pottery is decorated. Moreover, some decoration modes appear over great ranges of time and over large areas. This disadvantage, combined with the still not very abundant knowledge on this late pre-Columbian pottery in the Caribbean, causes great uncertainties in assigning pottery to different post-Saladoid series. Therefore, it is not tried to assign the Petite Rivière pottery to a series. The objective of the pottery analysis is to describe the pottery as accurately as possible, in order to be able to compare the Petite Rivière pottery with post-Saladoid material, excavated at other sites in the region.

The frequency distribution per category is presented in fig. 30 and table 7 (page 70). It shows that most of the sherds were body sherds, representing 74.1% of the sample in number. This was to be expected as bodies form the largest parts of vessels. Rims represent smaller parts and they are consequently reflected in the sample by 15.2%. Bases and griddles are usually more difficult to identify, unless they are represented by large fragments, griddle rims, or specific features such as the rough bottoms which griddles often have. These categories are less well represented in the sample, only by 4.9% and 4.8% respectively.

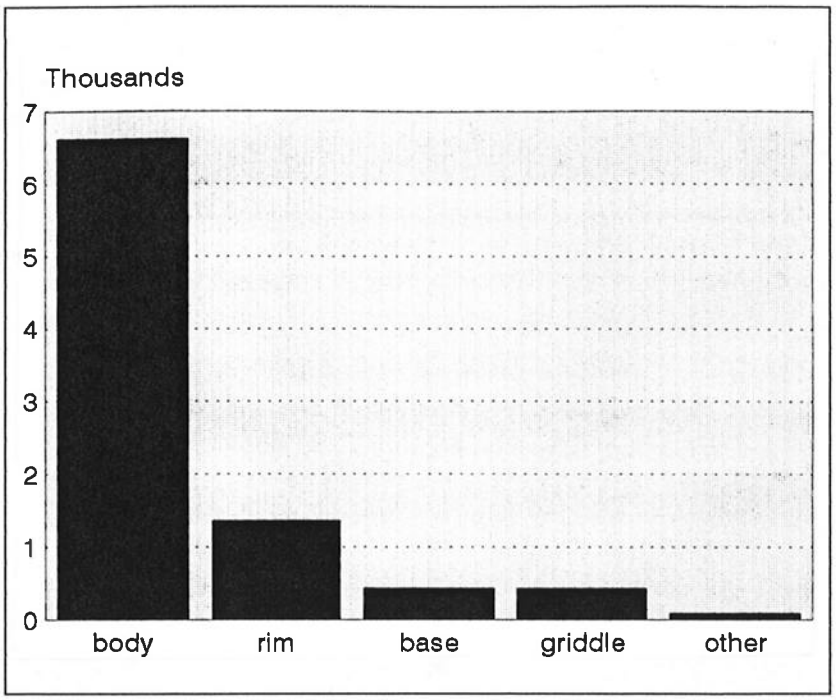


Figure 30. Petite Rivière pottery categories

category	N	%	weight (g)	N < 5 cm	N > 5 cm
body	6623	74.1	124004	4617	2006
rim	1368	15.2	48457	633	735
base	435	4.9	22636	132	303
griddle	429	4.8	19842	195	234
other	85	1.0	5271	30	55
total	8940	100.0	220210	5607	3333

Table 7. Petite Rivière pottery categories from the 1984 and 1995 excavations

4.2.3.3 The 'Appendages/Other' category

Only 1.0% of the total sample consisted of the category 'Appendages/Other'. The different pottery features identified in this category are represented in figs. 31-36 and table 8. In total 7.1% of this category could not be identified. A diagnostic feature of the Petite Rivière pottery is represented by *lugs* (23.5%). Lugs are usually considered to be representative for post-Saladoid pottery in general, but for Troumassan and Suazan Troumassoid pottery in particular (Rouse 1992:127-130). Different types of lugs can be identified. Some large lugs, can be thought to have functioned, except

for a decorative use, as handles. Their lengths vary from 60 to 88 mm, their widths from 62 to 130 mm, their thicknesses from 10 to 41 mm, and their weights from 65 to 298 g. The smaller lugs represent rim modifications. Rim modifications are seen as characteristic for Suazan Troumassoid pottery. The Petite Rivière specimens resemble, for example, those represented as Suazey modified rims at Caliviny island (Bullen and Bullen 1968[b]), at the sites of Lavoutte and Giraudy on St. Lucia (Bullen and Bullen 1970; Bullen et al. 1973), and at Suazoid sites on Martinique (Allaire 1977). Recently, however, it became clear that rim modifications can not be restricted to Suazoid pottery on the Windward Islands. They also occur on the Leeward Islands, e.g. in the post-Saladoid Saban sites of Spring Bay-3 and Kelbey's Ridge-2 (Hofman 1993:figs. 36f, 74c).

The presence of *griddle legs* (4.7%) in the sample, also demonstrates that the pottery is post-Saladoid. They are thought to be characteristic for Troumassan and Suazan Troumassoid pottery on the Windward Islands, although they also occur on the Leeward Islands, e.g. on Antigua (Rouse 1992:129). The rough and heavy Petite Rivière griddle legs resemble those presented as Suazey griddle legs of the Giraudy site on St. Lucia (Bullen et al. 1973:212), and those represented as post-Saladoid for sites on Martinique (Allaire 1977:249). Finer examples, however, were also found.

A total of six modelled-incised *zoomorphic and anthropomorphic representations* (figs. 33-34, page 74-75) were found at Petite Rivière. They are not represented in table 8, as they do not belong to the coded pottery sample. Three of them are zoomorphic, representing a bat, an unknown animal, and an unidentified animal. The others are anthropomorphic. Their heights range from 37 to 66 mm, their widths from 23 to 73 mm, and their thicknesses range from 22 to 36 mm. Their weights range from 18.5 to 99 g. One of them must have been attached to a rim (fig. 34a). For the two others it is not possible to see whether they were attached to a vessel or whether they functioned as independent features. The lengths of these representations vary between 37 and 88 mm. Their widths range from 23 to 75 mm, while their thicknesses are between 11 and 36 mm. The weights are between 18.5 and 302 g. The zoomorphic and anthropomorphic representations seem to belong to the post-Saladoid pottery, although further specifications can not be made. Similar human representations have been found at Union Island, the Grenadines (Sutty 1987:fig. 23-25).

A total of 30 *potstand* fragments, which is 35.3% of the total sample, was found. In general, their dimensions are rather modest, being approximately 80 mm high and 10 to 20 mm thick, covering a diameter of 12 cm. Several small *clay discs* with an unknown function were found (12.9%). Furthermore, a total of seven fragments (8.2%) of *handles* were found. Two different types could be distinguished, flat and broad, and very rounded handles. Finally, four *spindle whorls* (4.7%) were found. Three types are represented. Two spindle whorls are flat, with a diameter of 50 mm and a height of 54 mm. These specimens are convex, as if they have been made out of a former body sherd. A third spindle whorl is conical and heavier, with a diameter of 60 mm and a height of 60 mm. Similar conical spindle whorls were reported for the Morel III site on Guadeloupe and the

Troumassoid Paquemar complex on Martinique (Allaire 1992:4). The fourth spindle whorl is a more or less triangular and perforated object. Its height measures 60 mm, its base 57 mm, and the top 22 mm. The perforation has a diameter of 11 mm. A similar spindle whorl from the Giraudy site on St. Lucia was presented as being Suazey (Bullen et al. 1973:211). Both this and the Petite Rivière specimen have large incisions at the base, a feature which might suggest that they were also used as body stamps.

Of some items, only one fragment was found, such as of a *body stamp*, a *spout*, and an *applique*. The latter is similar to the applique found at the sites of Spring Bay-1c (Hofman 1993:fig. 64e) and on Kelbey's Ridge-2 on Saba (Hofman 1993:fig. 67b), although the Petite Rivière specimen was not notched.

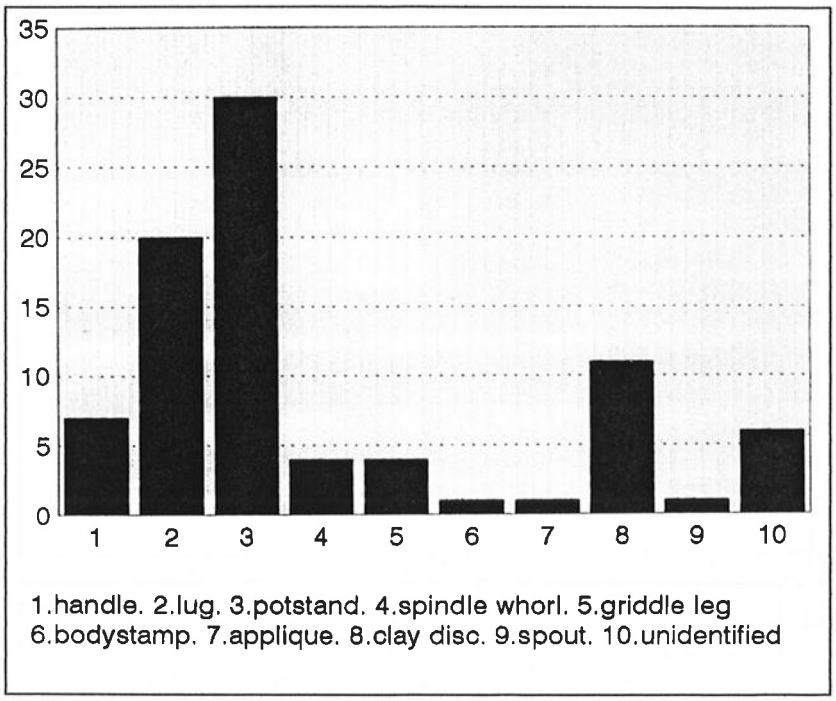


Figure 31. Petite Rivière 'appendages/other'

appendage/other	N	%	appendage/other	N	%
handle	7	8.2	body stamp	1	1.2
lug	20	23.5	applique	1	1.2
potstand	30	35.3	clay disc	11	12.9
spindle whorl	4	4.7	unidentified	6	7.1
griddle leg	4	4.7	total	85	100.0
spout	1	1.2			

Table 8. Petite Rivière 'appendages/other'

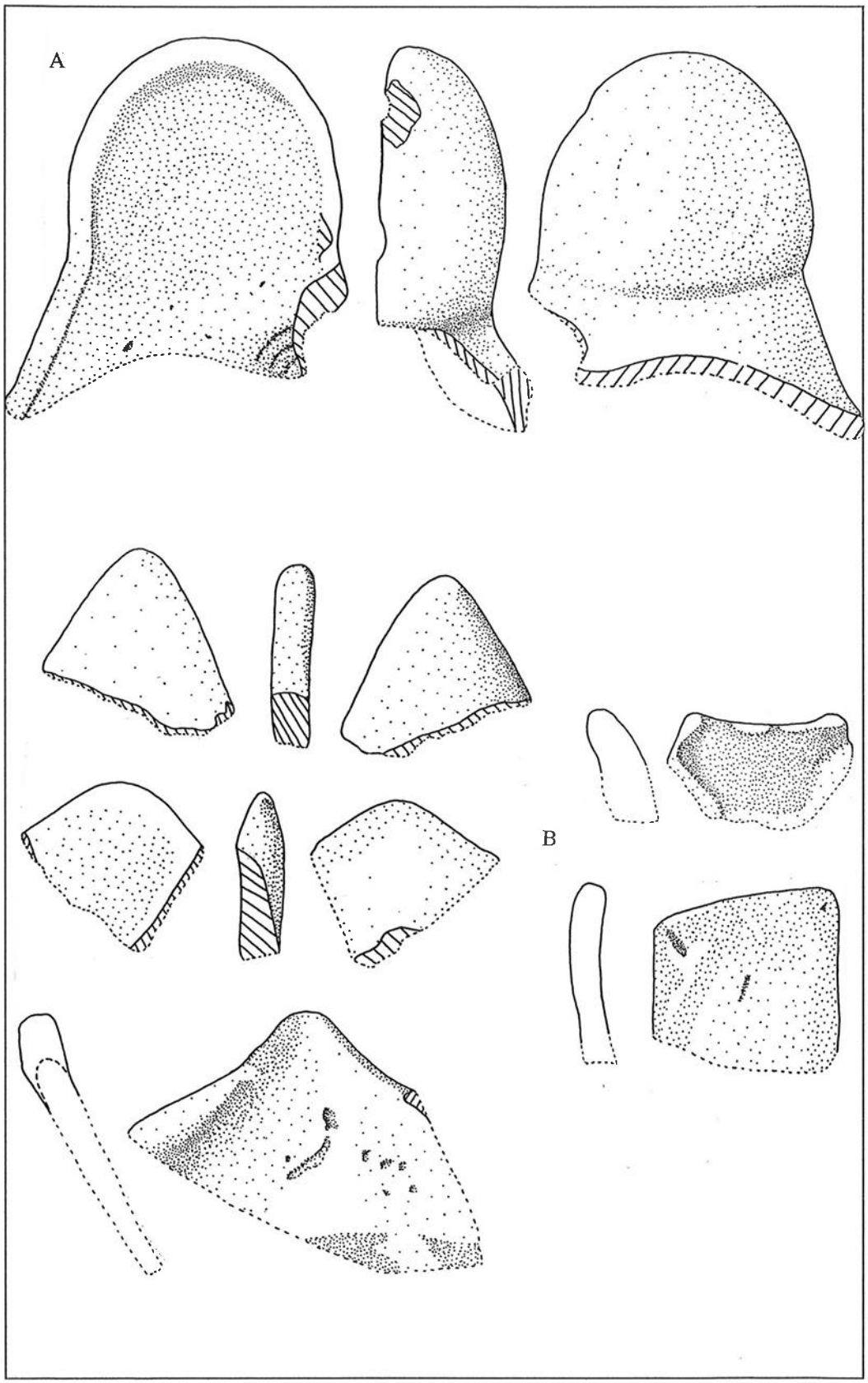


Figure 32. Petite Rivière 'appendages/other' (scale 1:2): A. lug; B. rim modifications

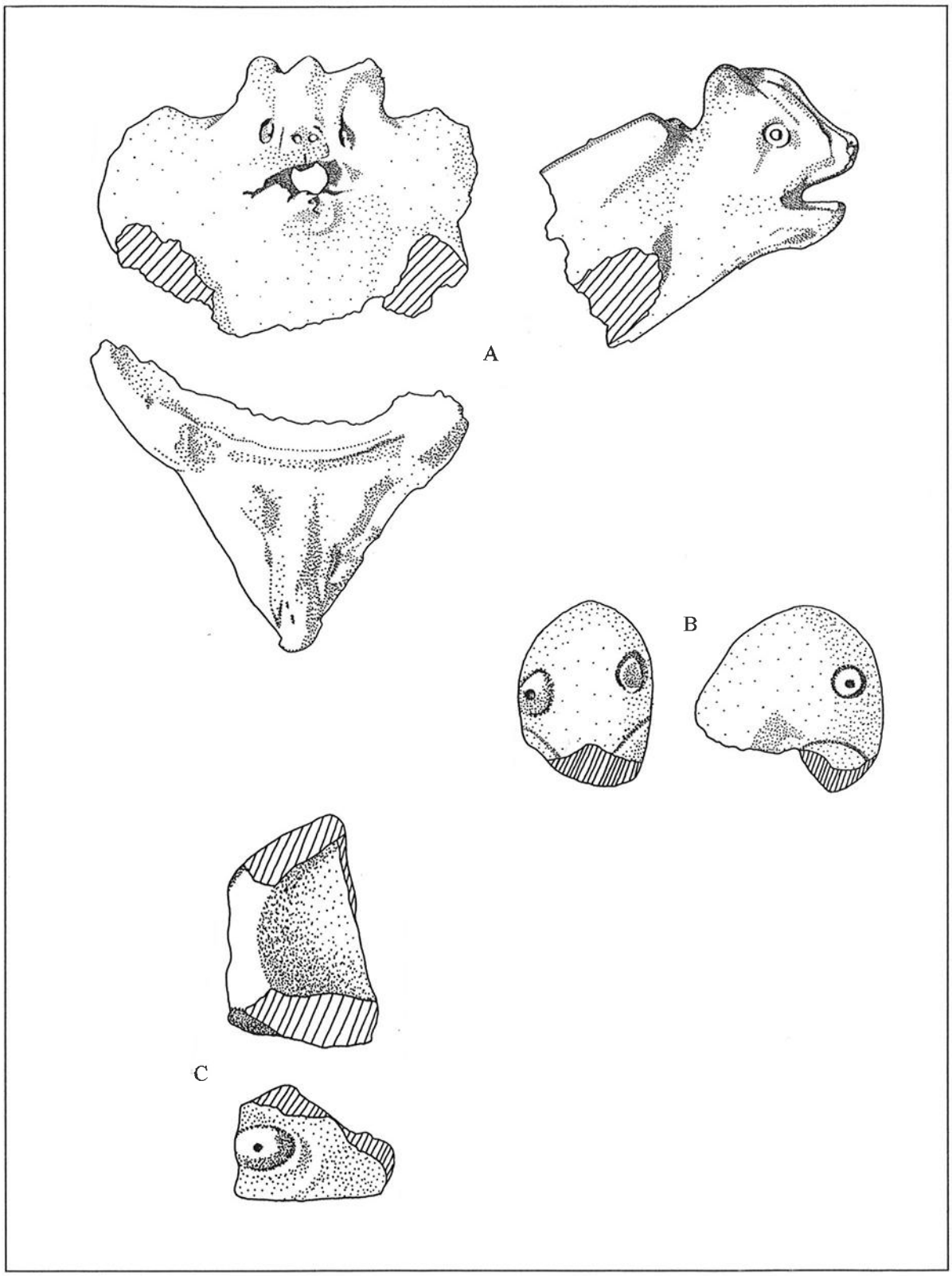


Figure 33 Petite Rivière zoomorphic representations: A. bat (scale 1:4); B. unknown animal (scale 1:2); C. unidentified animal (scale 1:2)

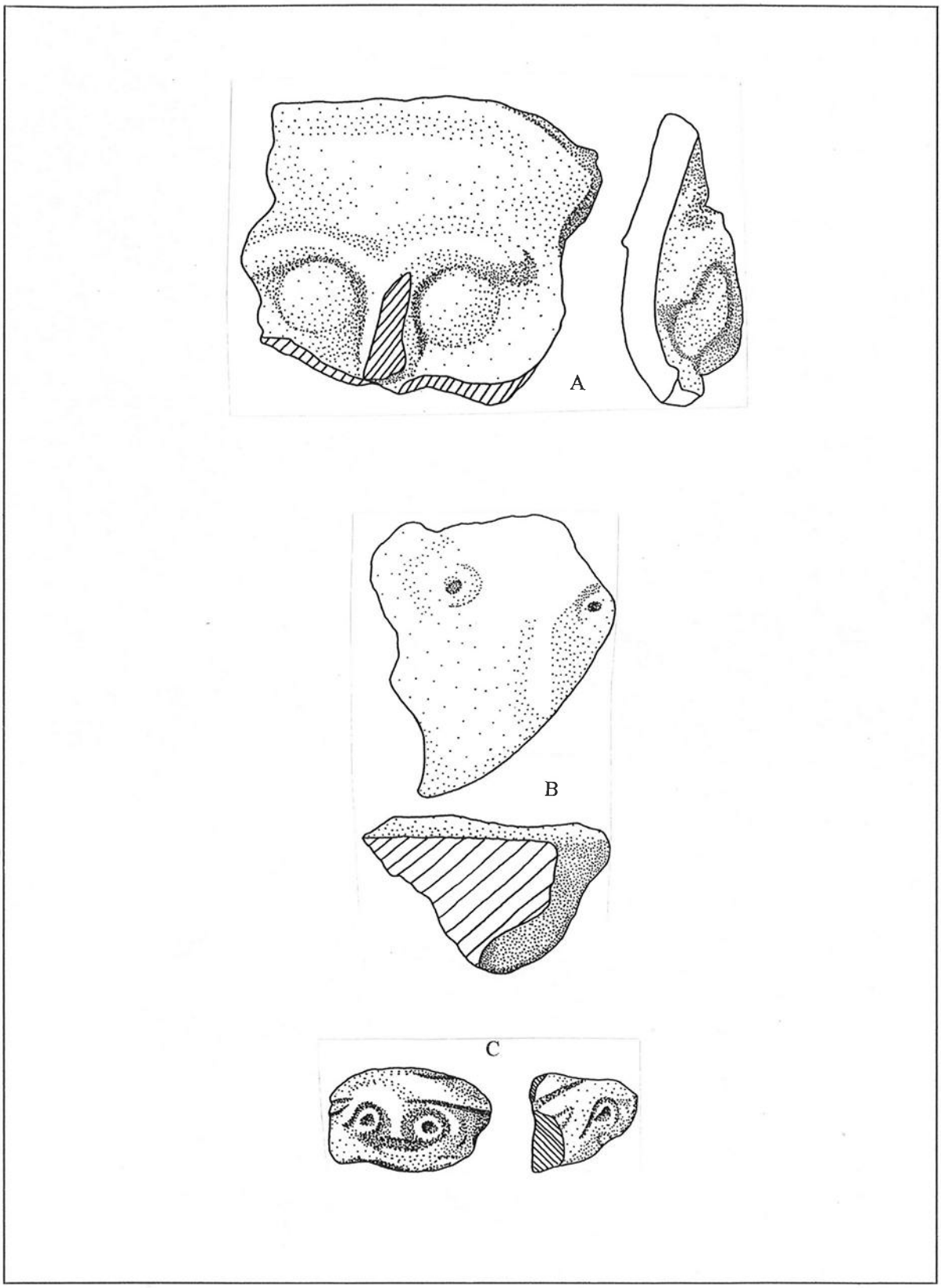


Figure 34. Petite Rivière anthropomorphic representations (scale 1:2)

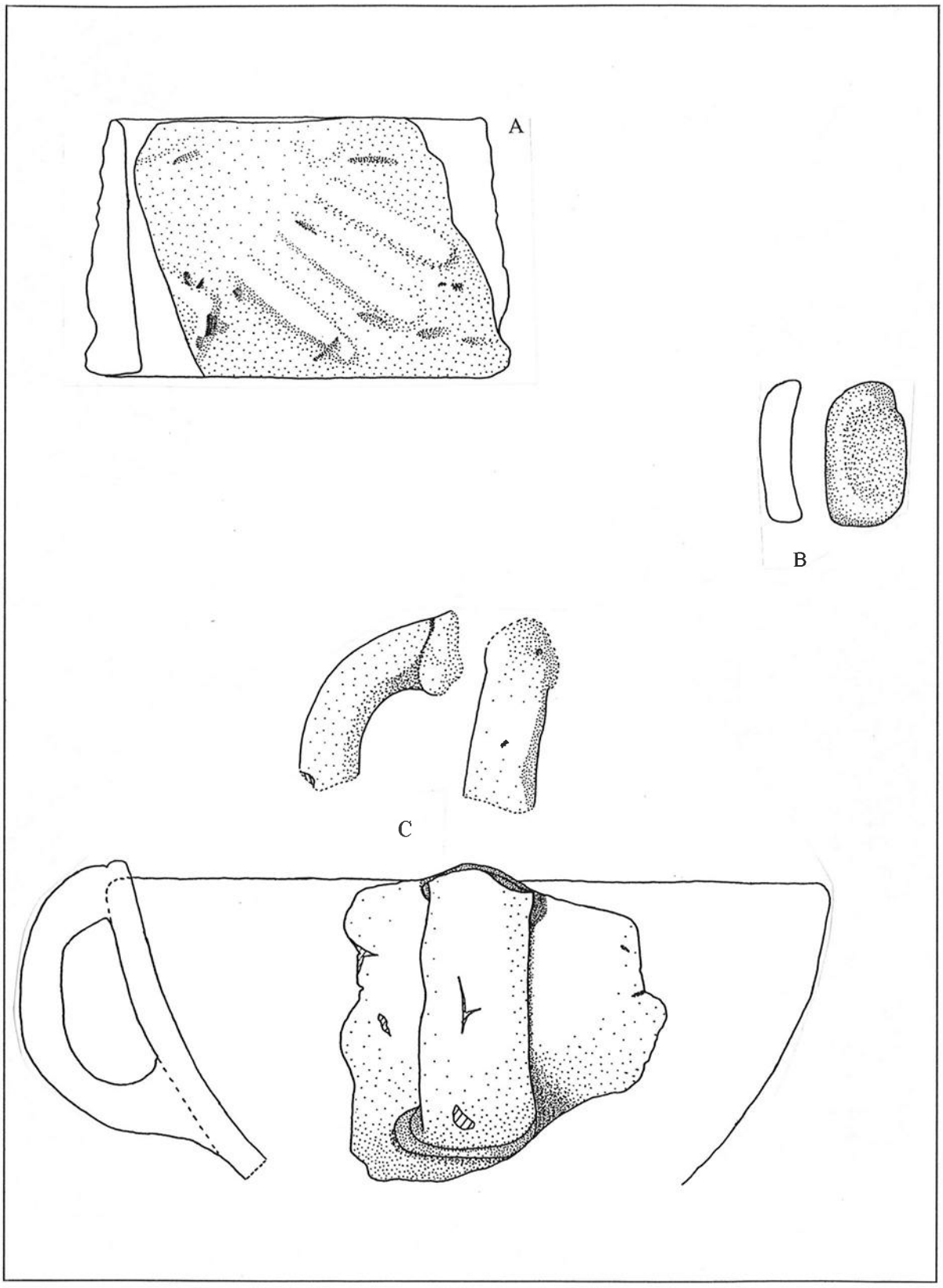


Figure 35 Petite Rivière 'appendages/other' (scale 1:2): A. potstand; B. clay disc; C-D handles

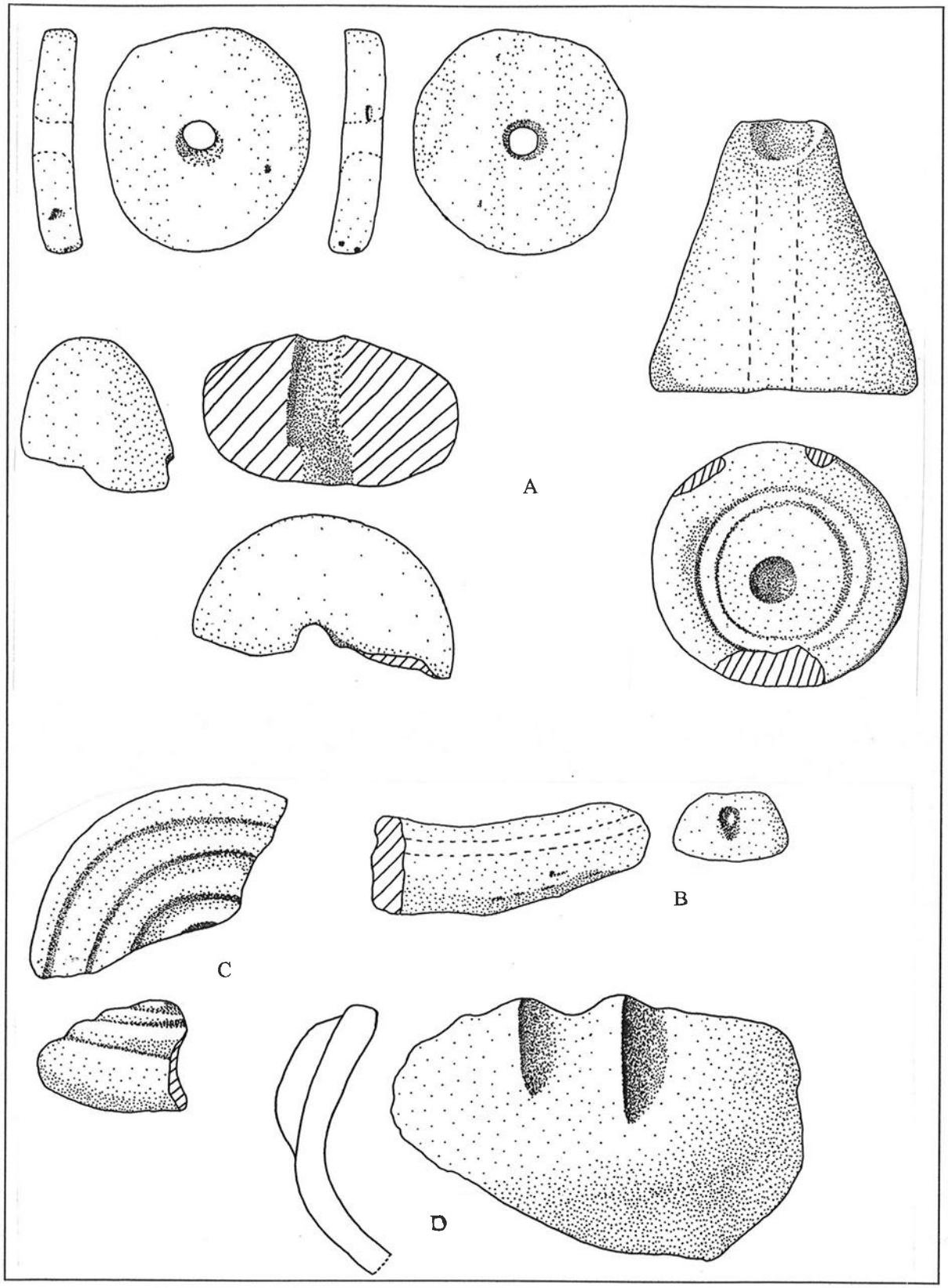


Figure 36 Petite Rivière 'appendages/other' (scale 1:2): A. spindle whorls; B. body stamp; C. spout; D. Applique

4.2.3.4 Decoration

A total of 125 sherds (1.4%) was decorated, and a number of different decoration techniques could be distinguished (figs. 37-39, table 9). The most frequently occurring decoration (76.0%) consisted of the incision of broad shallow lines (fig. 38, page 80). This decorative technique was also found to be characteristic for the Suazan Troumassoid assemblages of the sites of Grande Anse on Terre de Bas, les Saintes, and Morne Cybèle-2 on La Désirade (Hofman 1995[a]), Pointe Helleux on Grande Terre, Guadeloupe (Hoogland 1995), and for pottery from the Pointe de la Couronne Conchou site on Guadeloupe (Hofman personal communication 1996). It has also been reported for this period at different sites on Martinique (Allaire 1977). Similar incisions, however, have also been found at sites on the Leeward Islands, and can therefore not be used to assign the pottery to a series. A total of 12 sherds (9.6%) was finished with a red slip and decorated by narrow incisions (figs. 39a-b, page 81) or by bichrome slip. Those sherds belong to Late Saladoid ceramics. A total of four sherds had been decorated by fine incision and punctation (fig. 39c). This decoration mode is thought to be characteristic for the Mamoran Troumassoid subseries (Hofman personal communication 1996).

Only one example of finger indentation was found (0.8%). Finger indentation is usually considered to be one of the most prominent characteristics of Suazan Troumassoid pottery. Another decoration mode consisted of polychrome painting (13.6%). Polychrome painting seems to occur only on body sherds. Incised modelling with anthropomorphic representations made up 0.8% of the decorations and zoned-incised crosshatching or zic made up another 0.8%. A total of 4.8% of the sample was decorated by geometric modelling (fig. 39d), 1.6% by a side lug (fig. 39e), and an other 1.6% by punctation (fig. 39f). Finally, a total of 1415 sherds (15.8%), was covered by a red slip or paint, while a total of five sherds (0.1%), was covered by a beige slip or paint.

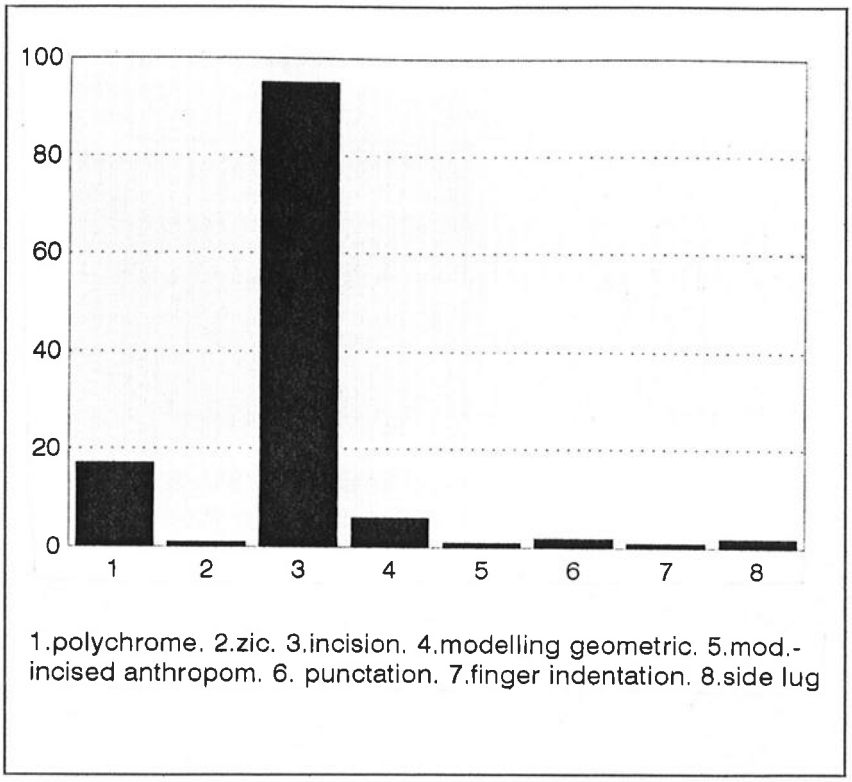


Figure 37. Petite Rivière decoration modes

decoration modes	N	%	decoration modes	N	%
polychrome paint	17	13.6	punctation	2	1.6
zic	1	0.8	finger indent.	1	0.8
incision	95	76.0	side lug	2	1.6
geometr. mod.	6	4.8	total	125	100.0
mod. inc. anthr.	1	0.8			

Table 9. Petite Rivière decoration techniques

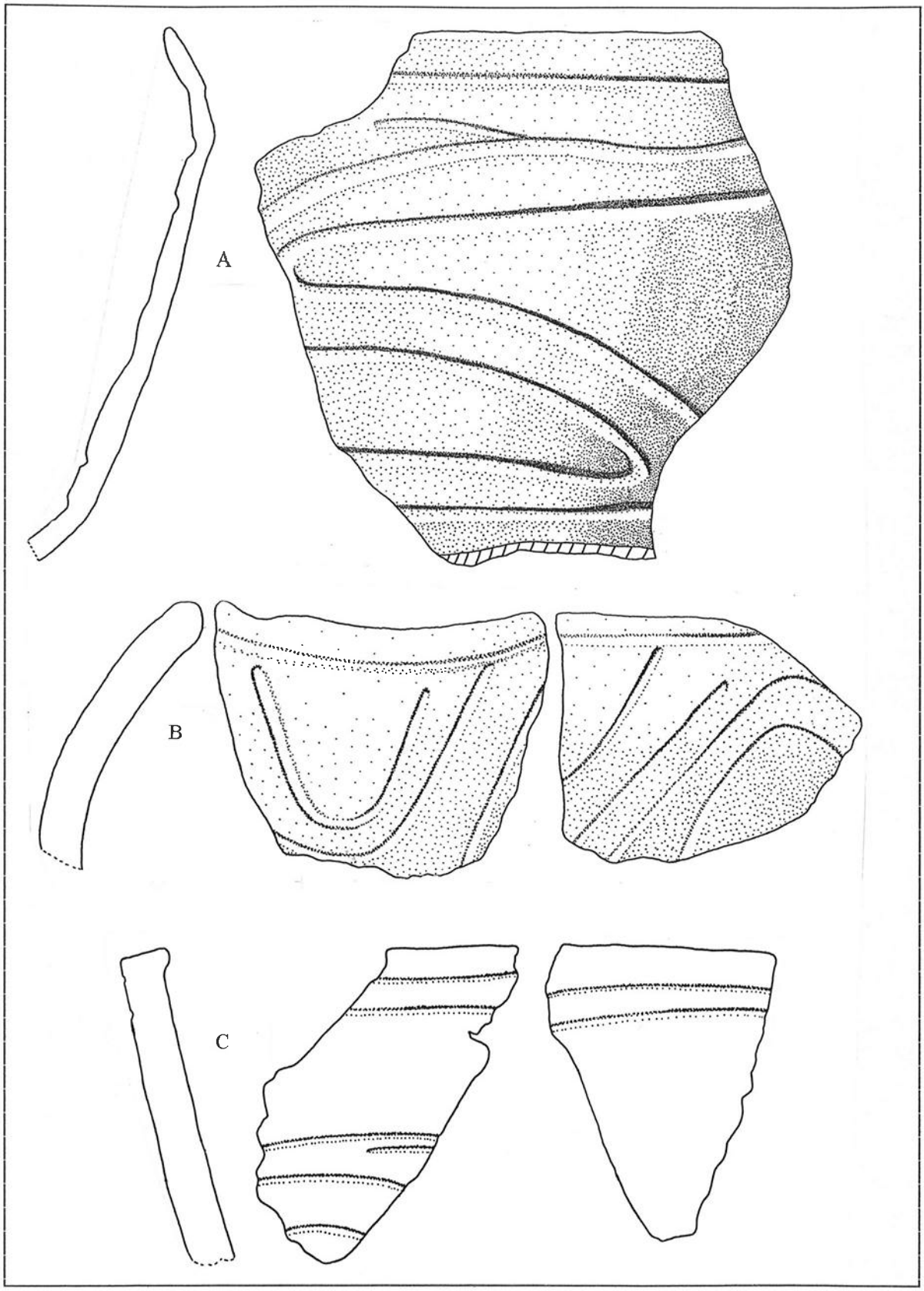


Figure 38. Petite Rivière rim sherds decorated by broad shallow incision (scale 1:2; except A. 1:4)

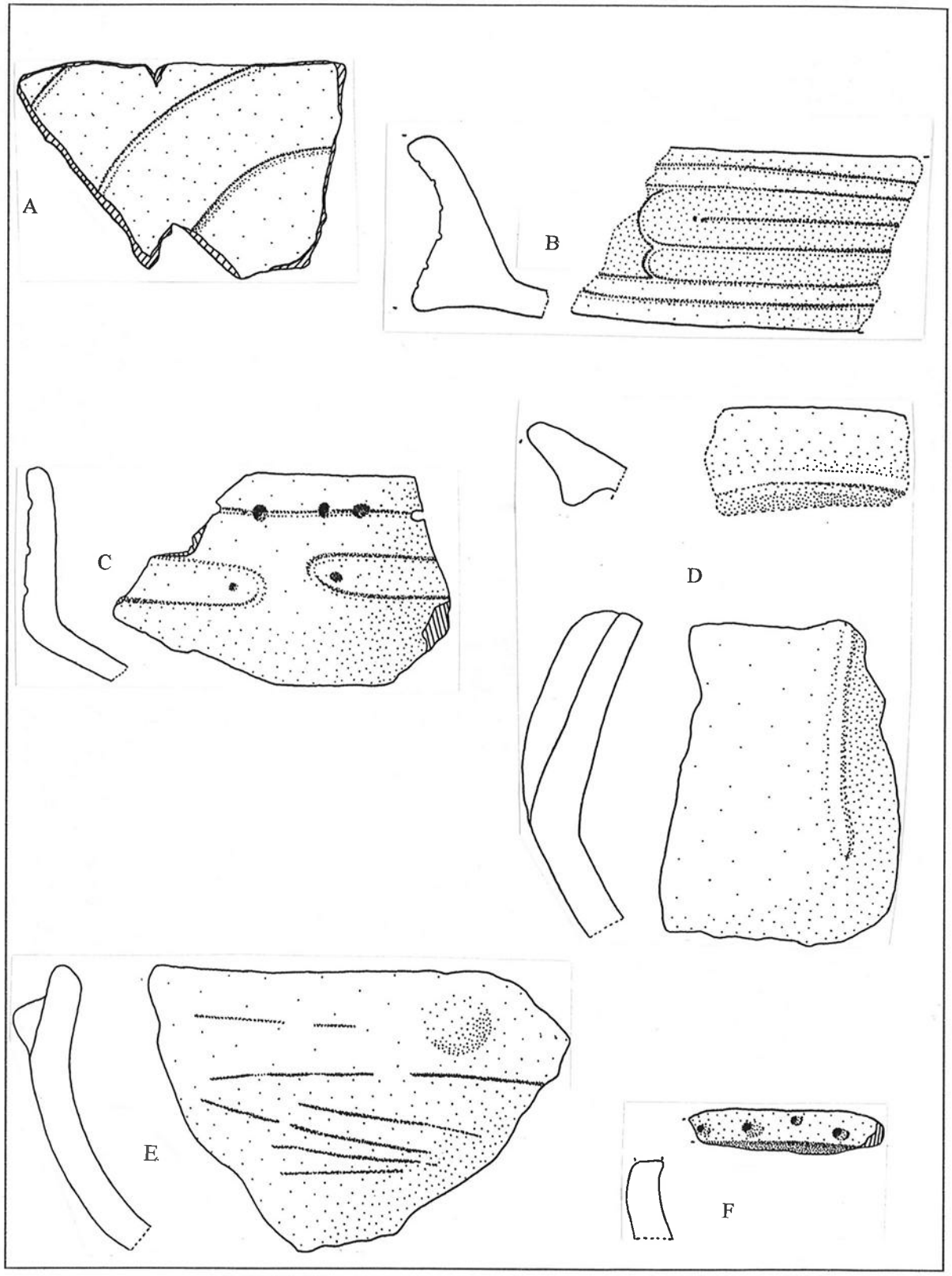


Figure 39. Petite Rivière decorated sherds (scale 1:2): A-B. sherd and griddle rim fragment decorated by narrow incision; C. rim sherd decorated by narrow incision

4.2.3.5 Base shapes

Hofman (1993:69) defined four base shapes (fig. 40).

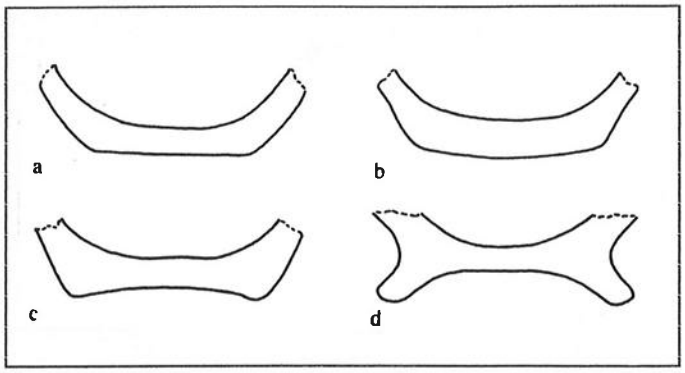


Figure 40. Base shapes (Hofman 1993:71): A. flat; B. convex; C. concave; D. pedestal or annular

For 23.4% of the base fragments it was impossible to identify the shape, as the dimensions were too modest. Most identifiable base shapes consisted of flat shapes, representing 69.0% (figs. 41-42, table 10). The remaining bases were convex (3.2%), concave (2.3%), concave high (1.6%), and pedestal/annular (0.5%). Diameters and thicknesses of the base fragments from the 1995 excavation units were recorded, although it must be remarked that only a few fragments were large enough to be informative. Diameters appear to range between 6 and 24 cm, while thicknesses range between 5 and 16 mm.

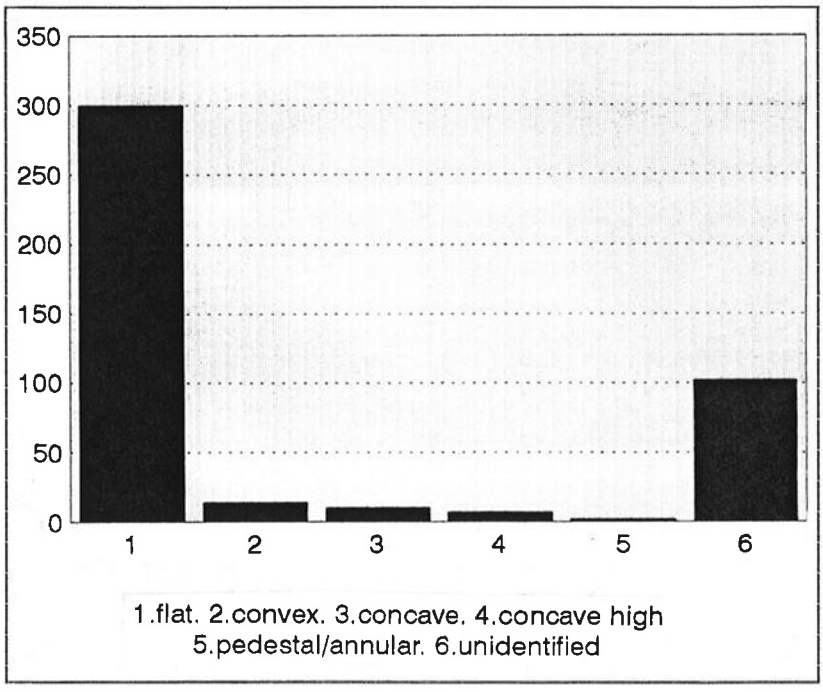


Figure 41. Petite Rivière base shapes

base shapes	N	%	base shapes	N	%
flat	300	69.0	pedestal/annular	2	0.5
convex	14	3.2	unidentified	102	23.4
concave	10	2.3	total	435	100.0
concave high	7	1.6			

Table 10. Petite Rivière base shapes

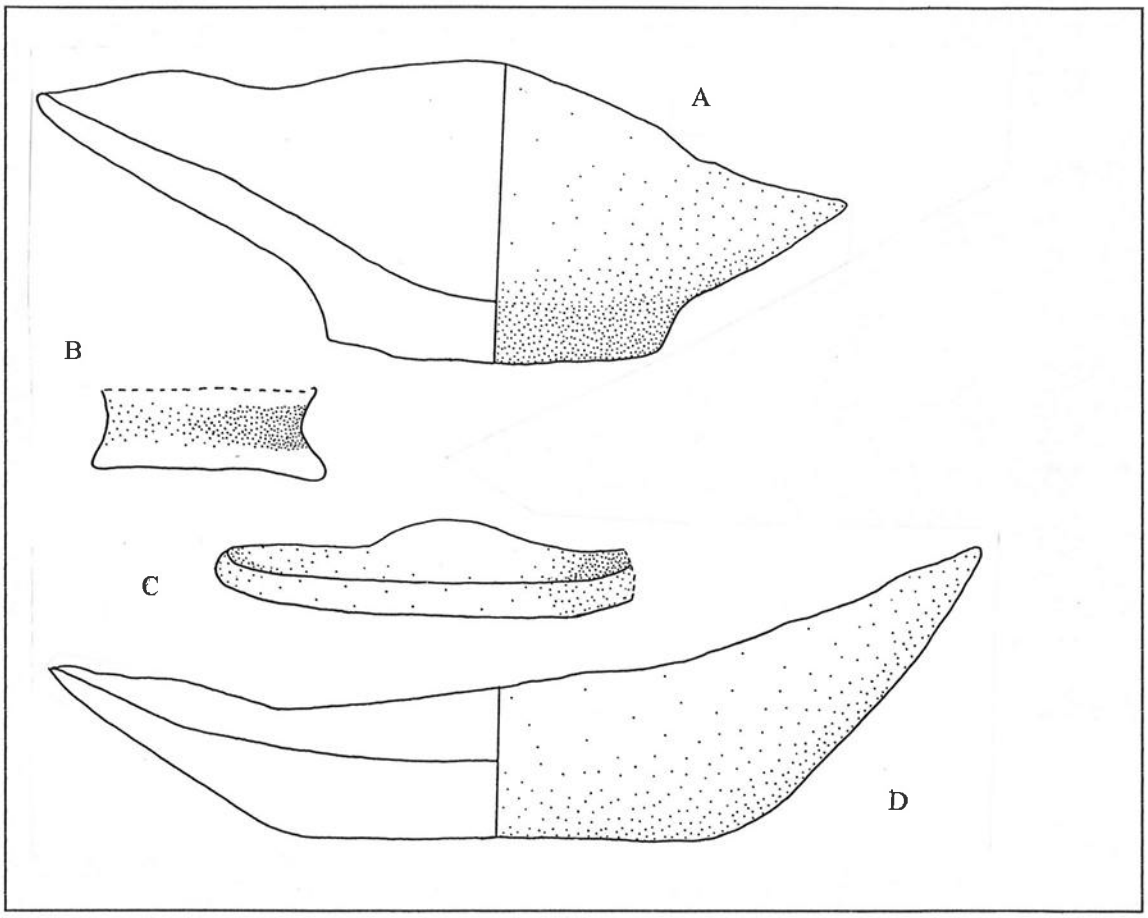


Figure 42. Petite Rivière base shapes (scale 1:2): A. convex; B. pedestal or annular; C. flat; D. flat

4.2.3.6 Griddle shapes

Hofman (1993:70) defined five griddle rim classes (fig. 43).

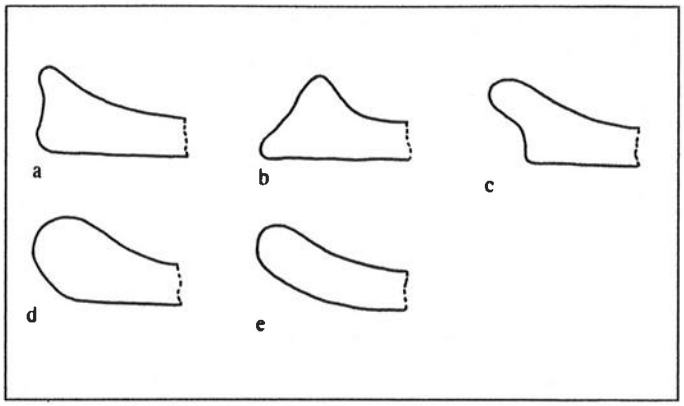


Figure 43. Griddle rim shapes (Hofman 1993:71): A. perpendicular raised; B. triangular raised; C. overhanging raised; D. rounded raised; E. unthickened or flat

Most of the shapes (57.1%) could not be identified (figs. 44-45, table 11). The identified shapes were straight (16.1%), triangular (17.3%), overhanging (2.3%), rounded (0.9%), unthickened (0.5%), and footed (5.8%). Diameters and thicknesses of the griddle fragments from the 1995 excavation units were recorded, but most griddle sherds were too small to be informative. Most of the plates of the griddles are between 10 and 16 mm thick, while their rims are between 20-24 mm thick. Their diameters are most often 42-44 cm.

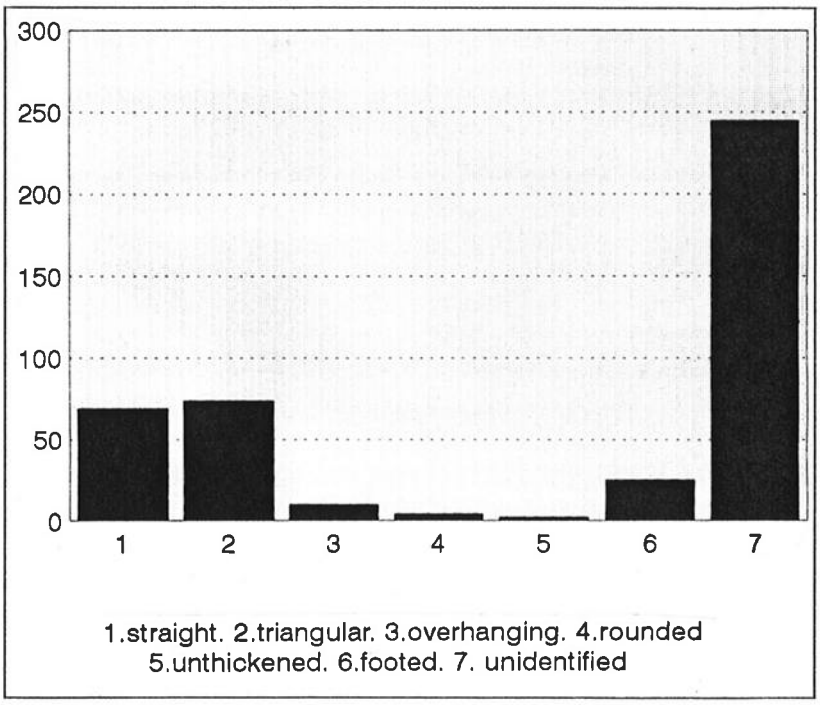


Figure 44. Petite Rivière griddle rim shapes

griddle shapes	N	%	griddle shapes	N	%
straight	69	16.1	unthickened	2	0.5
triangular	74	17.3	footed	25	5.8
overhanging	10	2.3	unidentified	245	57.1
rounded	4	0.9	total	429	100.0

Table 11. Petite Rivière griddle shapes

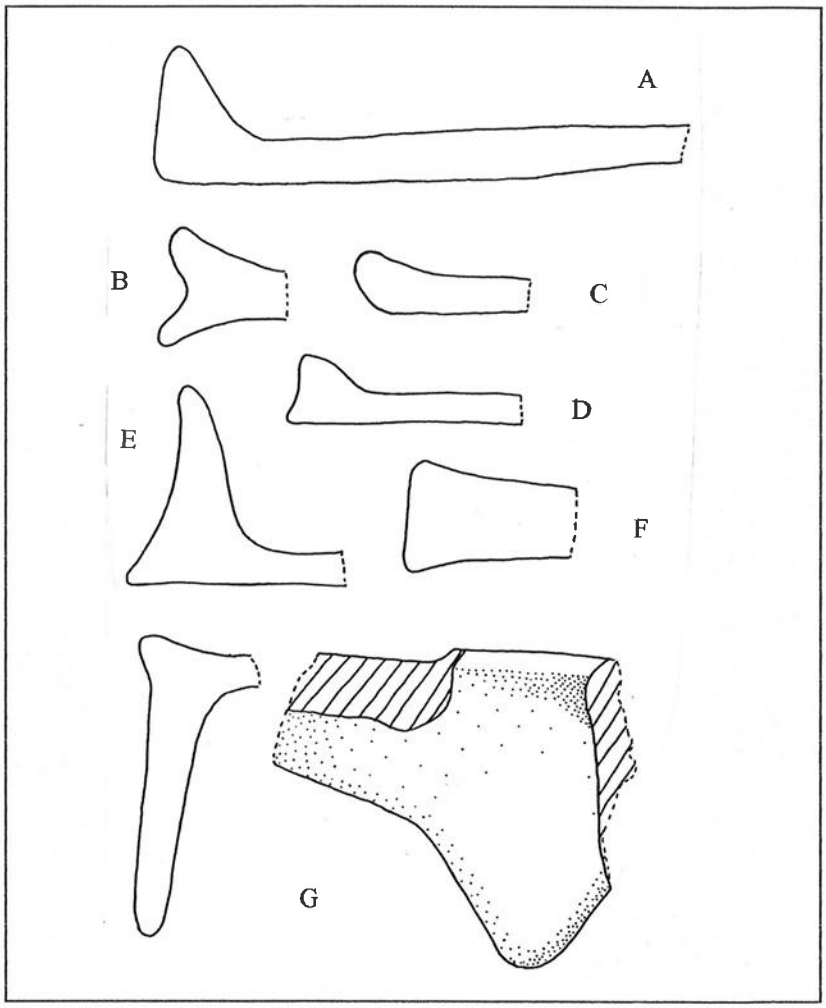


Figure 45. Petite Rivière griddle rim shapes (scale 1:2): A. straight; B. overhanging; C. rounded; D. perpendicular raised; E. perpendicular raised; F. straight; G. legged or footed

4.2.4 Coding of rim fragments larger than 5 cm

4.2.4.1 Introduction

Only rims larger than 5 cm were actually coded. Hofman (1993:62) defines this procedure as "recording by numerical code, the quantitative variations of different morphological, stylistic and technological attributes for each rim sherd". The coding procedure is mainly focused on the general vessel shape, although other attributes, such as wall profile, lipshape, rim profile, wall thickness, diameter, decoration, colour, firing colour, surface finishing, and the presence of slip, are also coded in order to provide information on the morphological, stylistic and technological treatment (Hofman 1993:62).

4.2.4.2 Wall profiles

In order to be able to infer vessel shape from rim sherds, Hofman (1993:62-65) used the classification, based on vessel contour, that was developed by Shepard (1963). Vessel contour is based on the combination of vessel profile and the symmetry about the vertical axis of the vessel, and the orifice. Shepard distinguishes simple, composite, inflected, and complex vessel contours. Simple contours are defined as smooth, uninterrupted straight or curving walls, without angle and inflection points. Composite contours have an angle point, and inflected contours have an inflection point in their contours. Complex contours have more than one angle or inflection point. For vessel orifices, Shepard distinguishes unrestricted, simple, dependent restricted and independent restricted forms. Unrestricted vessels have an open orifice and an end-point tangent that is vertical or inclined outward. Simple and dependent restricted vessels have a tangent at the end-point that is inclined inwards, but the corner lacks a constriction marked by a corner or inflection point. Independent restricted shapes have a corner point or an inflection point above a major point. Hofman (1993:64) added a sub-division in dish-shaped pottery, including vessels with a height/diameter ratio less than 0.30, bowl-shaped pottery, including vessels with a height-diameter ratio between 0.30 and 0.50, and jar-shaped pottery, including vessels with a height/diameter ratio greater than 0.50.

Using this classification of these two methods, the Petite Rivière pottery can be divided into nine main vessel shape categories (fig. 46, page 87).

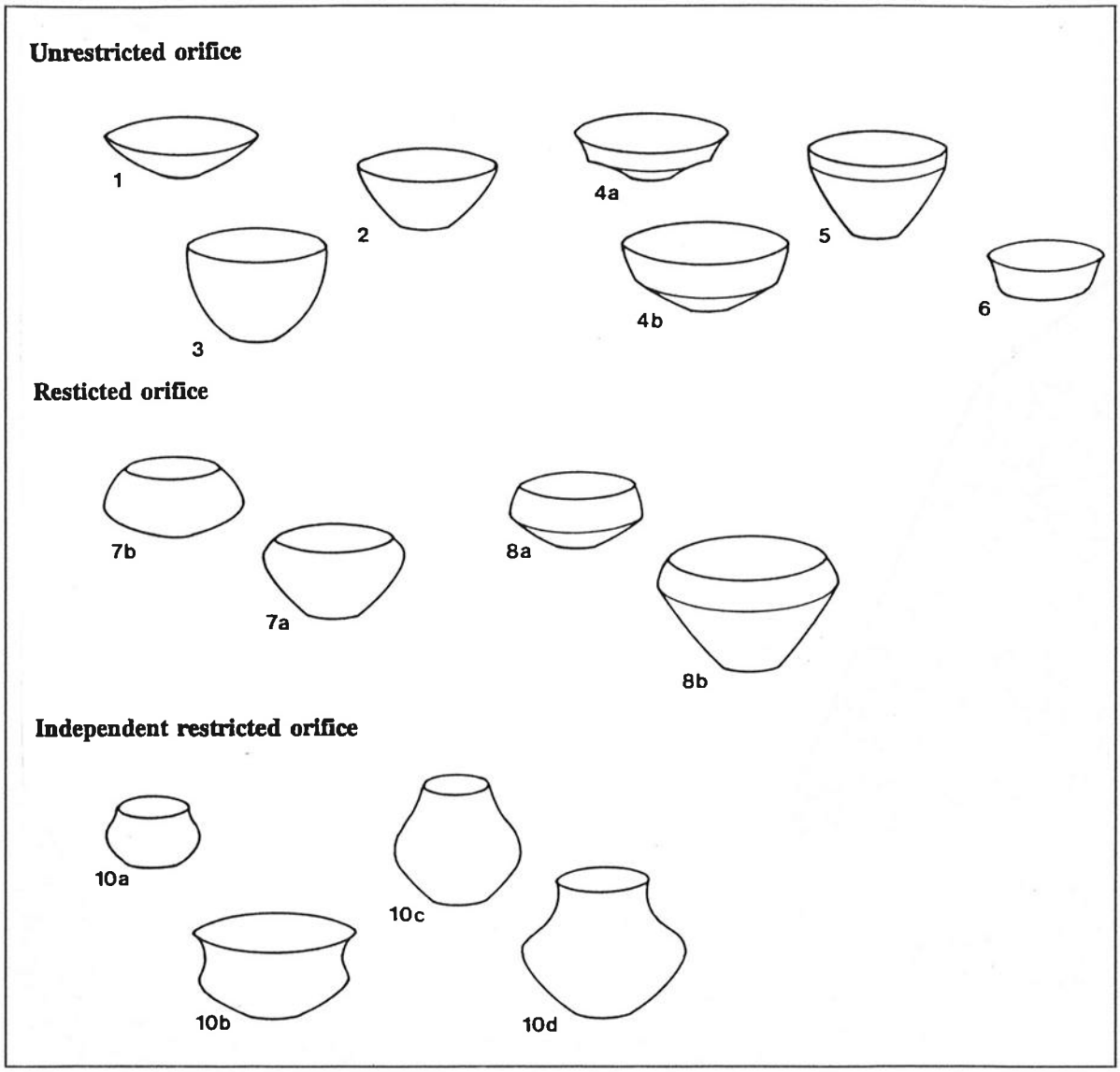


Figure 46. Vessel shape categories and their variations (Hofman 1993:65)

For a total of 658 rim sherds the vessel shape could be identified (figs. 47-50, table 12). The Petite Rivière vessel shapes are mainly represented by bowls with an unrestricted simple contour (40.3%). Less represented are dishes with an unrestricted simple contour (19.8%), jars with an unrestricted simple contour (18.4%),and bowls with a restricted simple contour (11.8%). Minor percentages were found for dishes or bowls with and unrestricted composite contour (5.7%), jars with an unrestricted composite contour (0.8%), bowls with an unrestricted inflected contour (2.1%), bowls or jars with a restricted composite contour (0.8%), and bowls or jars with an independent restricted inflected contour (0.3%).

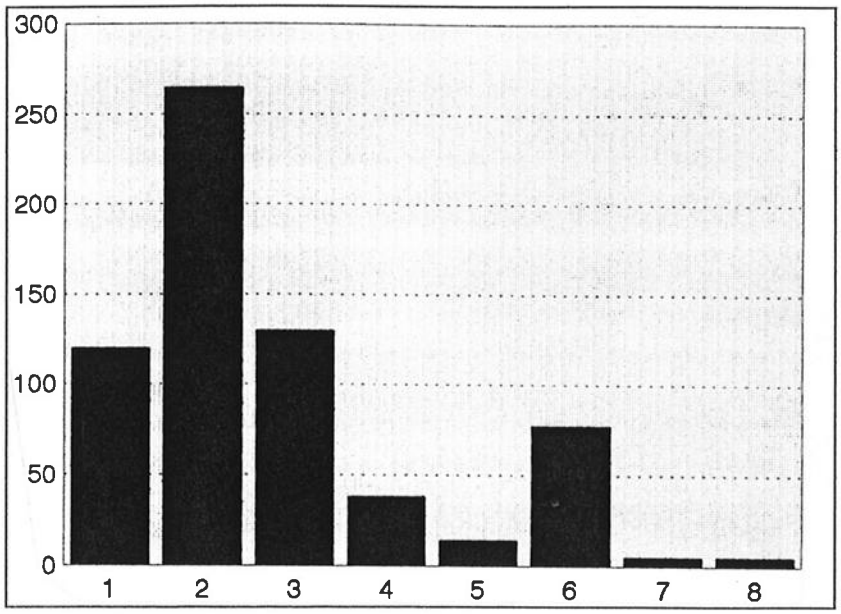


Figure 47. Petite Rivière vessel shapes (After Hofman 1993:65).

vessel shape	N	%	vessel shape	N	%
1	130	19.8	6	14	2.1
2	265	40.3	7	78	11.8
3	121	18.4	8	5	0.8
4	38	5.7	10	2	0.3
5	5	0.8	total	658	100.0

Table 12. Petite Rivière vessel shapes (After Hofman 1993:65).

1. Dish with an unrestricted simple contour
2. Bowl with an unrestricted simple contour
3. Jar with an unrestricted simple contour
4. Dish or bowl with an unrestricted composite contour: a. with a concave profile above the corner point, b. with a straight profile above the corner point
5. Jar with an unrestricted composite contour
6. Bowl with an unrestricted inflected contour
7. Bowl with a restricted simple contour: a. with the largest diameter above the half of the height, b. with the largest diameter below the half of the height
8. Bowl (a) or jar (b) with a restricted composite contour
10. Bowl or jar with an independent restricted inflected contour: a. bowl with a straight neck, b. bowl with an outflaring neck, c. jar with a straight neck, d. jar with an outflaring neck[42]

[42] Bowls with restricted complex contours (vessel shape 9) and bowls or jars with an independent restricted, compex contour (vessel shape 11) were not encountered.

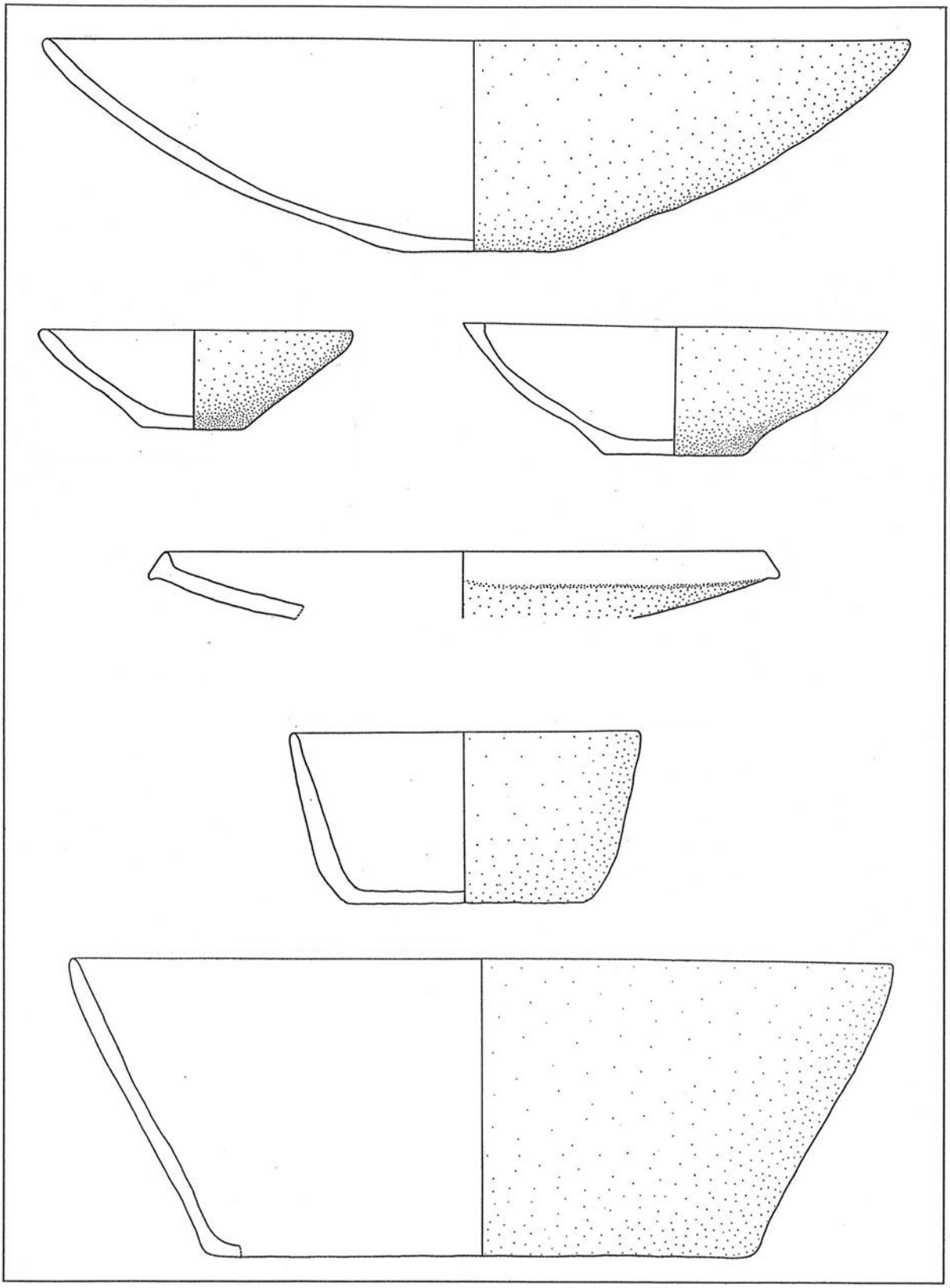


Figure 48. Petite Rivière dishes and bowls with unrestricted simple contours (scale 1:4)

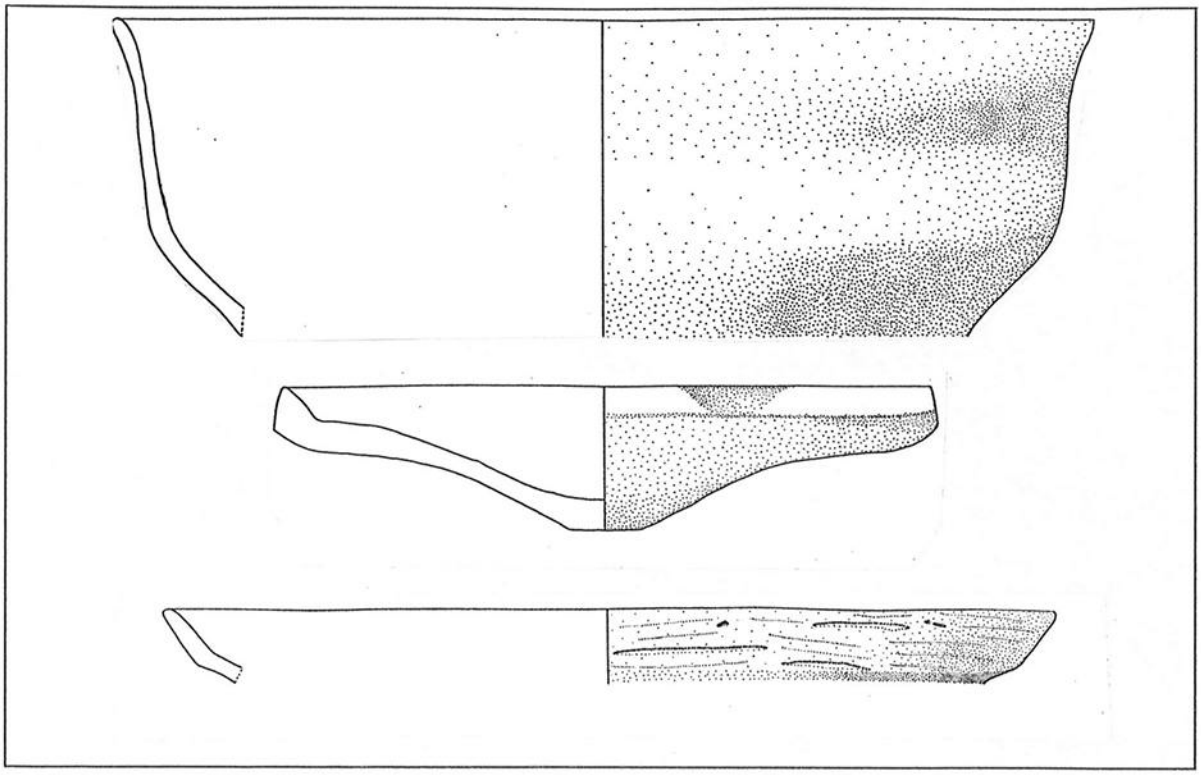


Figure 49. Petite Rivière dishes and bowls with unrestricted composite contours (scale 1:4)

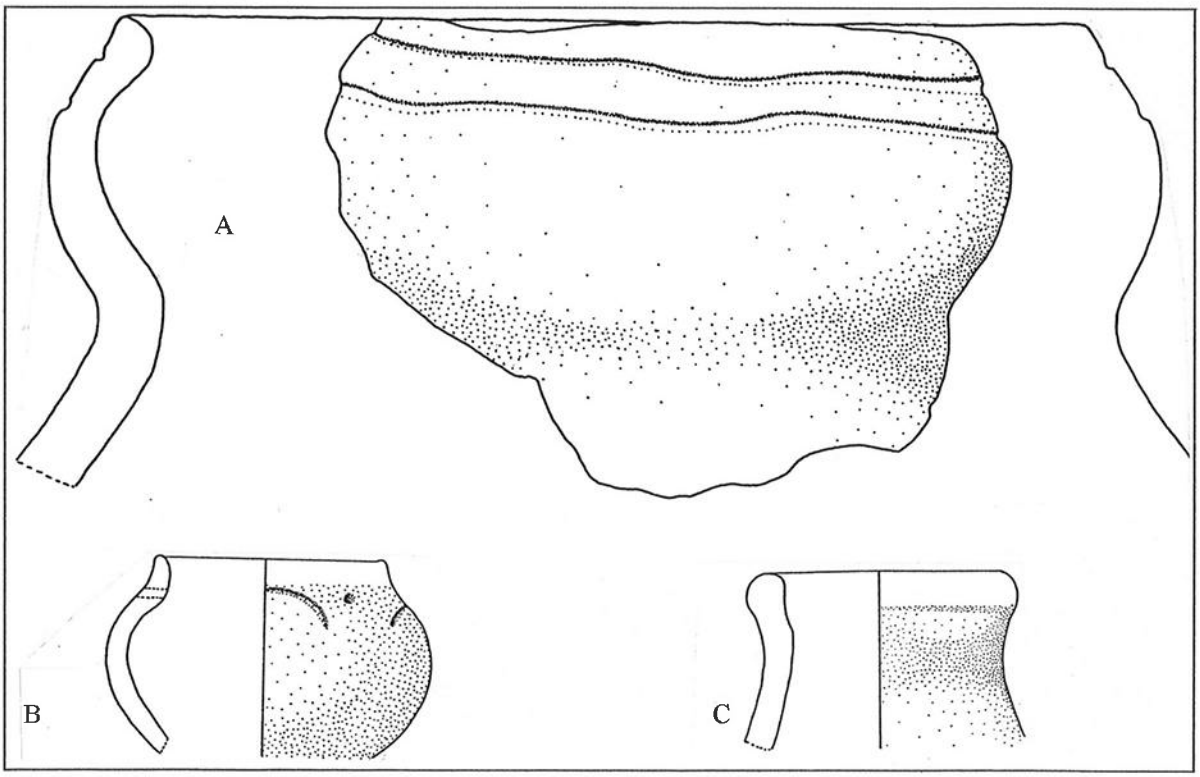


Figure 50. Petite Rivière bowls: A. bowl with independent restricted, complex contour (1:2); B-C. bowls with independent restricted, inflected contours (1:4)

4.2.4.3 Lipshapes

Lipshapes are often used in pottery analyses (e.g. Allaire 1977). The Petite Rivière pottery has rounded, flattened, inwardly thickened rims, outwardly thickened rims, double thickened rims, and flanged or bevelled lips.

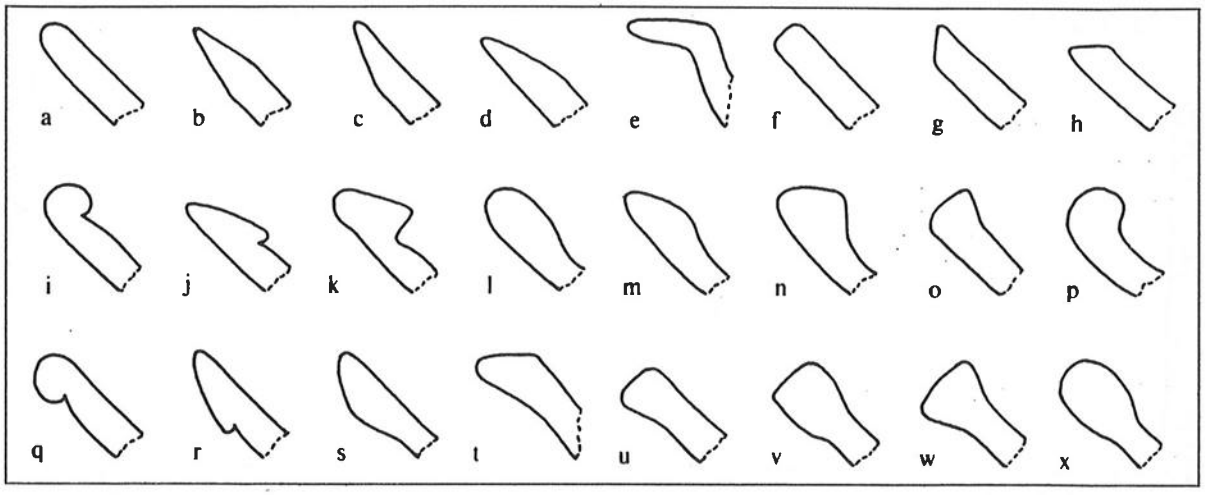


Figure 51. Main lip shapes and their variations (Hofman 1993:66).

- Rounded lips: a. unmodified, b. bilateral taper, c. external taper, d. internal taper
- Flanged lips: e. bevelled, labial flange
- Flattened lips: f. unmodified
- Bevelled lips: g. external bevelled, h. internal bevelled
- Inward thickened lips: i. internal semicylindrical bolster, j. internal bolster, taper, k, inward thickened, l. inward thickened, rounded, m. inward thickened, border, n. inward thickened, broad wedge, o. inward thickened, wedge, p. inward thickened rounded short
- Outward thickened lips: q. external semicylindrical bolster, r. external bolster, taper, s. outward thickened, taper, t. outward thickened, wedge, u. outward thickened, flat
- Double thickened lips: v. double thickened, flat, w. wedge, bilateral, x. double thickened lips.

Lip shapes could be identified for 685 rims larger than 5 cm (fig. 52, table 13). Mostly represented are rounded lips (69.6%). A second category consisted of inwardly thickened lips (15.9%). Inwardly thickened rims are often considered to be characteristic for Suazoid pottery (e.g. Allaire 1977). Minor percentages consisted of flattened lipshapes (6.4%), outwardly thickened lipshapes (6.3%), double thickened lipshapes (1.2%), and bevelled lipshapes (0.6%). Except for the inwardly thickened rims, no diagnostic lipshapes were encountered. Rim profiles are predominantly straight and vertical (75.8%).

lipshape	N	%	lipshape	N	%
rounded	477	69.6	double thickened	8	1.2
flattened	44	6.4	bevelled	4	0.6
inward thickened	109	15.9	total	685	100.0
outward thickened	43	6.3			

Table 13. Petite Rivière lip shapes

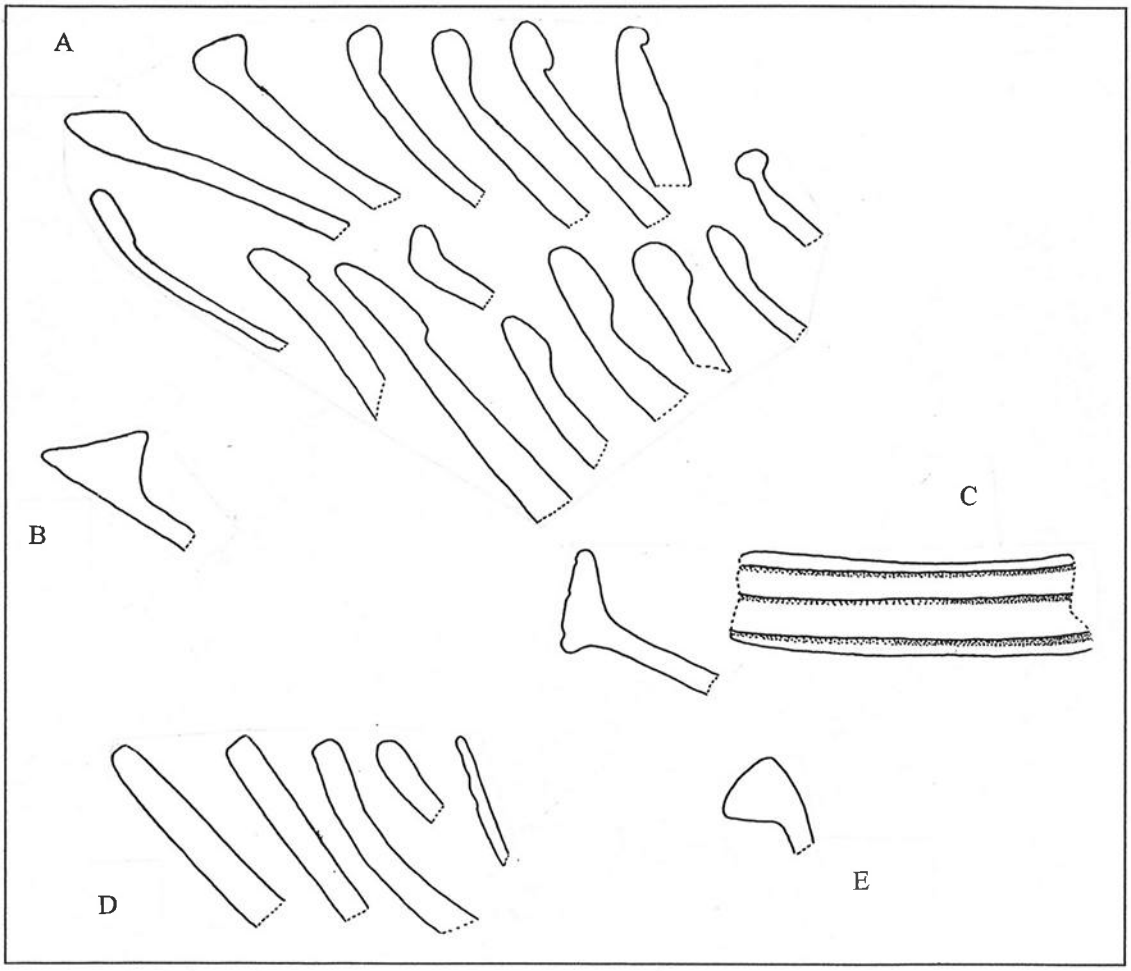


Figure 52. Petite Rivière lipshapes (scale 1:2): A. inwardly thickened; B. inwardly thickened; C. bevelled; D. rounded and flattened; E. outwardly thickened

4.2.4.4 Wall thickness

The thickness of the vessel was measured 2 cm below the lip portion. Hofman (1993:67) defined four main classes in order to facilitate the processing of the data. They range from 1 to 5 mm, 6 to 8 mm, 9 to 11 mm, and 12 to 15 mm. For the Petite Rivière pottery, which is rather heavy, wall

thicknesses are predominantly 6-8 mm (45.2%) or 9-11 mm (43.6%). Thicknesses of 1-5 mm and 12-15 mm are only represented by 2.9% and 8.3% respectively (table 14).

wall thickness	N	%
1-5 mm	19	2.9
6-8 mm	298	45.2
9-11 mm	288	43.6
12-15 mm	55	8.3
total	660	100.0

Table 14. Petite Rivière wall thicknesses

4.2.4.5 Orifice diameter

The orifice diameter was calculated with a diameter template, which was also used to calculate the percentage of the rim[43]. Seven classes were distinguished. They range from 1 to 10 cm, 11 to 20 cm, 21 to 30 cm, 31 to 40 cm, 41 to 50 cm, 51 to 60 cm, and 61 to 70 cm. Orifice diameters could be identified for 693 sherds. The diameters range between 8 and 62 cm (table 15). Most of the vessels have an orifice diameter between 21 and 30 cm (29.3%). Others had diameters of 31-40 cm (20.6%), 1-10 cm (17.0%), 11-20 cm (15.2%), or 41-50 cm (13.7%). Only a few vessels (4.2%) had an orifice diameter larger than 50 cm.

orifice diameter	N	%	orifice diameter	N	%
1-10 cm	118	17.0	41-50 cm	95	13.7
11-20 cm	105	15.2	51-60 cm	27	3.9
21-30 cm	203	29.3	61-70 cm	2	0.9
31-40 cm	143	20.6	total	693	100.0

Table 15. Petite Rivière orifice diameters

[43] In the case of incurving rims or boat-shaped and kidney shaped vessels, the diameters of the orifice are not informative for the diameters of the vessels (Hofman 1993:67).

4.2.4.6 Surface colour

As Hofman (1993:67) summarizes, "the colour of a sherd can be the result of the clays used to make the vessel, the conditions of firing, the addition of clay slips, and of alterations during use and in the post-depositional environment (Rice 1987:343-345)". In order to create a standardized analysis, the colours of both the outside and inside surfaces were described with the help of a Munsell Color Soil Chart (table 16).

outer colour	N	%	inner colour	N	%
1. grey	47	6.8	1. grey	12	1.7
2. dark grey/black	12	1.8	2. dark grey/black	4	0.6
3. brown grey/grey brown	4	0.6	3. brown grey/grey brown	4	0.6
4. dark greyish brown	16	2.3	4. dark greyish brown	7	1.0
5. light brown-brown	29	4.2	5. light brown-brown	21	3.1
6. dark brown-very dark brown	126	18.3	6. dark brown-very dark brown	105	15.3
7. reddish grey-dark reddish grey	40	5.8	7. reddish grey-dark reddish grey	18	2.6
8. reddish brown	199	29.0	8. reddish brown	224	32.6
9. red	214	31.2	9. red	293	42.5
total	687	100.0	total	688	100.0

Table 16. Munsell colour groups of the Petite Rivière outer and inner surfaces (After Hofman 1993:67).

1. grey (Hue 10YR 5/1, 4/1; Hue 7.5YR N6/, N5/; Hue 5YR 4/1,3/1)
2. very dark grey/black (Hue 10YR 3/1, 2/1, 2/2; Hue 7.5YR N2/, N3, N4; Hue 5YR 2/1)
3. light brownish-grey/greyish-brown (Hue 10 YR 6/2, 5/2; Hue 7/1, 6/1, 5/1)
4. dark greyish-brown (Hue 10YR 4/2, 3/2)
5. light brown/brown (Hue 10YR 6/3, 5/3, 4/3; Hue 7.5YR 6/4)
6. dark brown/very dark brown (Hue 7.5YR 5/2, 5/4, 4/2, 4/4, 3/2)
7. reddish-grey/dark reddish-grey (Hue 5YR 5/2, 4/2)
8. light reddish-brown/reddish-brown (Hue 5YR 6/3, 6/4, 5/3, 5/4, 4/3, 4/4, 3/2, 3/3, 3/4, 2/2; Hue 2.5YR 5/4, 5/6, 5/8, 4/4, 4/6, 4/8)
9. red (Hue 2.5YR 5/4, 5/6, 5/8, 4/4, 4/6, 4/8, 6/6; Hue 10R 3/6, 5/6, 5/8, 4/6, 4/8; Hue 7.5YR 5/6, 5/8, 4/6, 4/8)

For 687 sherds the outer surface colour could be described, and for 688 the inner colour. Most of outer surfaces of the Petite Rivière pottery are red (31.2%), reddish-brown (29.0%), and dark

brown-very dark brown (18.3%). The inside surfaces are also predominantly red (42.5%), reddish brown (32.6%), and dark brown-very dark brown (15.3%). Red slipped surfaces are considered to be characteristic for Suazan Troumassoid pottery (e.g. Allaire 1977, Hofman 1995[a]).

4.2.4.7 Firing colour

The firing colour of sherds is supposed to relate to firing conditions (Rice 1987:345). The colours of the core and the sub-surfaces can be studied from a freshly broken cross section. The colours of the Petite Rivière cross sections can be divided in five categories:

1 red core and sub-surfaces, resulting from complete oxidation
2 grey, brown, or black core and brown or reddish-brown sub-surfaces, implying that the pottery is incompletely to relatively well oxidized
3 dark grey or black core and red or light grey sub-surface, resulting from incomplete oxidation
4 light grey core and sub-surface, resulting from incomplete oxidation or reduction
5 dark grey or black core and sub-surface, resulting from complete reduction

For 6.4% of the rim sherds the firing colour could not be identified. The rest of the sample (table 17) had predominantly grey, brown, or black cores and brown or reddish brown sub-surfaces (83.1%), and were probably incompletely to relatively well oxidized. The presence of irregularly fired pottery was demonstrated by asymmetrical sub-surfaces (16.1%).

core colour	N	%
grey, brown, or black core and brown or reddish brown sub-surface	572	83.1
dark grey or black core and red or light grey sub-surface	3	0.5
light grey core and sub-surface	29	4.2
dark grey or black core and sub-surface	84	12.2
total	688	100.0

Table 17. Petite Rivière core colours

4.2.4.8 Surface finishing (table 18)

The following modes of surface finishing were distinguished after Hofman (1993:68):

1 unfinished crude surfaces, which are left unfinished, possibly with visible coils
2 smoothed surfaces, which have a regular matt appearance
3 lightly burnished surfaces, which show a light combination of lustre and matt which is the result of incomplete burnishing
4 highly burnished surfaces, which show a light combination of lustre, with the appearance of striations, and matt
5 polished surfaces, which are regular with a uniform lustre

For 588 sherds the surface finishing of the outer surface could be analysed. The outer surfaces are mainly highly burnished (48.8%). The pottery is not as crude as is sometimes suggested for post-Saladoid pottery. Only 1.0% of the pottery has really crude surfaces. Other rims are finished by light burnishing (16.5%) and some surfaces are smoothed (13.3%). A total of 8.7% of the pottery has been finished by polishing, and 11.7% of the pottery has lightly scratched surfaces on a highly burnished surface. The inner surfaces are also predominantly highly burnished (39.8%), while an other large group has been lightly burnished (23.1%). Other sherds were smoothed (12.1%), polished (14.3%) or lightly scratched (9.3%). Only 1.4% of the inner surfaces is crude.

inner surface	N	%	outer surface	N	%
crude	8	1.4	crude	6	1.0
smoothed	69	12.1	smoothed	78	13.3
lightly burnished	132	23.1	lightly burnished	97	16.5
highly burnished	227	39.8	highly burnished	287	48.8
polished	82	14.3	polished	51	8.7
scratched	53	9.3	scratched	69	11.7
total	571	100.0	total	588	100.0

Table 18. Surface finishing modes of the Petite Rivière inner and outer surfaces

4.2.4.9 Slip

The presence of red slip can be explained as a decoration technique or as a surface treatment. Hofman (1993:69) distinguishes different parts of the vessels red slip was applied to:

1 overall
2 the exterior
3 the exterior and the lip
4 the interior
5 the interior and the lip
6 the lip

As for the Petite Rivière pottery, 38.2% of the rim sherds larger than 5 cm had a red slip finishing (table 19). It can be concluded that rims bear a red slip more often than the other parts of the pottery, considering that only 15.8% of the total Petite Rivière sample was finished by a red slip. As for the rims, most of the slip was applied overall (52.0%), while slip applied to the interior and the lip occurred in 23.5% of the sample. For 15.7% of the rim sherds, the application of slip was limited to the interior surface of the sherd. The application of red slip is a feature that is well known from post-Saladoid ceramics, and especially from the Suazan Troumassoid sub-series (Allaire 1977; Hofman 1995[a]).

red slip	N	%	red slip	N	%
overall	146	52.0	interior and lip	66	23.5
exterior	10	3.6	lip	4	1.4
exterior and lip	11	3.8	total	281	100.0
interior	44	15.7			

Table 19. Red slip on Petite Rivière pottery

4.2.4.10 Decoration

The coding of decoration on rim sherds will not be described in detail as decoration as a general feature was already described in paragraph 4.2.3.4. Decorations on rim sherds will be only described in order to examine whether they differ from decorations occurring in the complete studied pottery sample. A total of 3.3% of the rims are decorated (table 20, page 98). This percentage is rather similar to the percentage for decorated pottery (1.4%). The decoration modes

are also similar. Decorations predominantly (79.5%) consist of linear incisions (fig. 53). Only one rim was found with geometric modelling (4.1%), an other with an anthropomorphic modelled-incised applique (4.1%), and one with finger indentation (4.1%). A total of two rim sherds were decorated with side lugs (8.2%). Finger indentation is usually seen as an important characteristic of Suazan Troumassoid pottery (Drewett 1991; Harris 1991[a], 1991[b]). In the Petite Rivière sample it is only marginally represented.

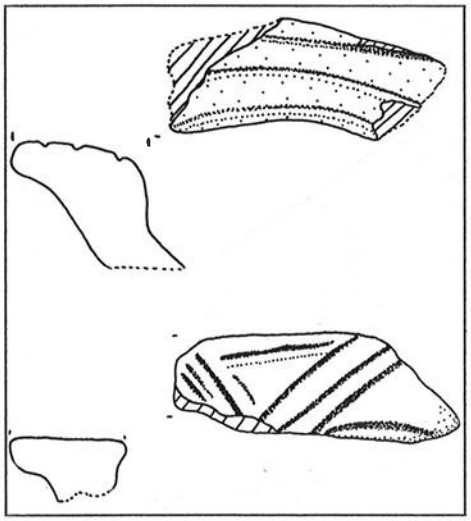


Figure 53. Petite Rivière rim sherds decorated by incision (scale 1:2)

decoration mode	N	%
incision (linear or curvilinear)	19	79.5
modelling (geometric)	1	4.1
modelled incised applique (anthropomorphic)	1	4.1
finger indentation	1	4.1
side lugs	2	8.2
total	24	100.0

Table 20. Decoration modes of the Petite Rivière rims larger than 5 cm

4.2.5 Conclusions

The three C14 dates obtained from the 1984 and the 1995 excavations (see paragraph 3.4.7) suggest that the site was at least occupied between AD 600-652, between AD 1012-1154, and between AD 1312-1402. The first range can be considered to coincide with the Late Saladoid

period and the second range may be considered to belong to the period of the first Suazan Troumassoid phases. The third range may be contemporary with Late Suazan Troumassoid.

As mentioned earlier, the Petite Rivière pottery does not allow easy affiliations to the Ceramic series of the cultural chronological framework. A minor component of the pottery can be contributed to Late Saladoid ceramics on the basis of its fine incisions. This component could very well be correlated to the range of AD 600-652. The remaining pottery is post-Saladoid, although no clear distinctions can be made of what series or sub-series influenced it. This is especially difficult for the plain ware, which comprises the main part of the pottery found in this later phase (Bullen and Bullen 1970; Bullen et al. 1973:200). The dates of AD 1012-1154 and AD 1312-1402 might correlate with this late pre-Columbian pottery. These dates might be compared with the following dates:

— AD 900 for the Suazan Troumassoid component of Morel lV on Guadeloupe (Allaire 1992)
— AD 1028-1179/AD 1188-1208, AD 1230-1326 for the Suazan Troumassoid site of Pointe Helleux on Guadeloupe (Hoogland 1995)
— AD 1010 for Carriacou on the Grenadines (Bullen, Bullen and Branford 1973)
— AD 1100-1500 for Chancery Lane on Barbados (Drewett and Harris 1991)
— AD 1100 ± 150 for the Greenland site on Barbados (Bullen and Bullen 1968[a])
— AD 1158-1278 and AD 1160-1280 for the Suazan Troumassoid site of Grande Anse, Terre de Bas, Les Saintes (Hofman 1995[a-b])
— AD 1230-1326 for the Suazan Troumassoid site of Morne Cybèle-2 on La Désirade (Hofman 1995[a])
— AD 1250 for the Lavoutte site on St. Lucia (Bullen and Bullen 1970).

It must be remarked, however, that most of these dates will not be very reliable, as their provenance is unknown. The provenance of the dates provided by Hoogland (1995) and by Hofman (1995[a-b]) is known. They were obtained from *Cittarium pica* or crab remains from clear archaeological contexts. The samples were analysed in the Laboratory for Isotopic Research in Groningen (The Netherlands), and the BP dates for *Cittarium pica* have been calibrated with the Groningen calibration programme CAL 15 using the calibration curve for marine shell[44].

The post-Saladoid Petite Rivière pottery appeared to mainly consist of bowls, jars, and dishes with an unrestricted simple contour, and bowls with a restricted simple contour. The vessels have predominantly rounded or inwardly thickened lips, and straight, vertical rim profiles. Most thicknesses of the vessels fall into the range of 6 to 11 mm, while most orifice diameters range between 21 and 30 cm. The inner and outer surfaces of the Petite Rivière pottery are mainly red,

[44] Stuiver and Braziunas 1993.

reddish-brown, and dark brown to very dark brown. Most of the inner and outer surfaces have been highly or lightly burnished. The sherds had predominantly grey, brown, or black cores and brown or reddish brown sub-surfaces, implying that they were incompletely to relatively well oxidized. A total of 16.1% of the sherds had been irregularly fired. A total of 38.2% of the rim sherds larger than 5 cm had a red slip finishing, in most cases covering the overall rim and the interior and the lip to a lesser extent. Decoration mainly consists of incision.

The post-Saladoid component of the Petite Rivière pottery, exhibits some features that might provide more specific information. Bodu (personal communication 1996) assigned this component to the Suazoid series. The Petite Rivière pottery has indeed some characteristics that are considered by some authors to be diagnostic for the Suazan subseries, but they have not been found in impressive quantities. Some of those characteristics are not uniquely found on the Windward Islands. The Petite Rivière rim lugs and rim modifications, for example, are very similar to those described as Suazoid by Harris (1991[a]:41; 1991[b]) and to examples from sites on the Leeward Islands, e.g on Saba (Hofman 1993). Therefore, the presence of lugs can only be used to demonstrate that the pottery is post-Saladoid.

Finger marking is considered to be one of the most prominent characteristics of Suazan Troumassoid pottery (McKusick 1960). It has abundantly been found at archaeological sites on Barbados, for example at the Chancery Lane and Silver Sands sites where it was assigned to Suazoid pottery (Harris 1991[a]:95), and at the sites of Hillcrest and Heywoods where it was assigned to Troumassoid pottery (Harris 1991[b]:524). At Petite Rivière it occurred only once.

The many red slipped surfaces of the Petite Rivière pottery could be considered to be diagnostic for Suazoid pottery. Red painted and broadly incised pottery with Suazan thickened rims, has also been reported from the Suazoid (components of the) sites of Lavoutte on St. Lucia (Bullen and Bullen 1970), Macabou on Martinique (Allaire 1977:190), Morel lV, Anse-à-l'Eau, and Gros Cap on Guadeloupe, from Folle Anse on Marie-Galante (Allaire 1992:4), Pointe Helleux, Sainte Anne on Guadeloupe (Hoogland 1995), Grande Anse on Terre de Bas, Les Saintes and Morne Cybèle-2 on La Désirade (Hofman 1995[a]:2-4), and from Pointe de la Couronne Conchou (Hofman personal communication 1996). However, characteristics in the form of fingernail impressions and heavily scratched surfaces are lacking for the Petite Rivière pottery. Scratched pottery, however, is also rare on Barbados in complexes that are thought to be Suazan Troumassoid (Harris 1991[a]:39). For the Lavoutte and Giraudy sites on St. Lucia scratched pottery and decoration by finger indentation have also been reported to be present but rare (Bullen and Bullen 1970:69; Bullen et al. 1973:200). Moreover, Bullen (1970:150) reports that "Suazey scratched" is known as far northward as the Cupecoy Bay site on St. Martin. The pottery also shows resemblances with pottery of the Leeward Islands in the applique (fig. 36d) and the punctated rim (fig. 39f).

The non-containers could not be assigned to a series either. The presence of footed griddles only demonstrates that the pottery is post-Saladoid. Small human representations are considered to be characteristic for Suazan Troumassoid pottery, but only a few sites, such as the Lavoutte site (Bullen and Bullen 1970:71-77), and the Pointe Helleux site (Hoogland 1995) produced real figurines, for which the exaggeration of the eyebrows and noses is characteristic. The representations of human faces that were found at Petite Rivière resemble those found on the Miss Pierre site on Union Island, the Grenadines (Sutty 1987:figs.23,25). Similar spindle whorls as those of the Petite Rivière site were reported for the Morel III site on Guadeloupe and the Troumassoid Paquemar complex on Martinique (Allaire 1992:4), and the Giraudy site on St. Lucia (Bullen et al. 1973:211).

As a final concluding remark it can be said that the Petite Rivière pottery consists of a very small Late Saladoid component, and a large post-Saladoid component. The latter can not be defined more specifically, it can only be concluded that influences from both the Leeward Islands as from the southern Windward Islands are visible. It even shows resemblances with Saban pottery assemblages (Hofman 1993). It is clear that Suazan Troumassoid pottery is not entirely uniform in the Windwards (Allaire 1992:9). Allaire (1992:2-5) expresses the opinion that Guadeloupe, being the northernmost of the Windward Islands, must have been closely involved with the Leeward Islands and that late Ceramic similarities also hint to the Mamora Bay and Freeman's Bay complexes of Antigua (Rouse 1976; Rouse et al. 1995) and related assemblages from St. Martin (Bullen and Bullen 1966, 1974). This might be confirmed by four sherds from the Petite Rivière site, which have been decorated by fine incision and punctation, and by red slipped sherds that were decorated by broad shallow incision. These decoration modes are thought to be characteristic for the Mamoran Troumassoid subseries of, for example, Antigua (Hofman personal communication 1996). The whole northern Caribbean seems to contrasts with the southernmost Windward Islands (Allaire 1992:13) and the Petite Rivière pottery fits this picture.

4.3 STONE ARTEFACTS

4.3.1 Introduction

At most pre-Columbian sites in the Caribbean stone artefacts can be found. According to Walker (1985:182), however, it appears to be a general phenomenon that there are few lithics in relation to the other components of a site's assemblage, although due to preservational bias, durable stone might be expected to be overrepresented instead of underrepresented. Quantities and the morphological and technological characteristics of stone artefacts vary with the different pre-Columbian time periods, with the geology of a particular island and of the immediate environs of a particular site. This diversity results from differences in cultural preferences, levels of technology, and availability of stone resources.

Stone artefacts are usually defined as lithics which show traces of having been worked or used (Haviser 1992), such as tools and ornaments. Stone artefacts and stones that do not occur naturally at the site have been included in the sample studied. At the Petite Rivière site stone artefacts are a rather small category, although raw materials that are suitable for their manufacture are abundantly available on the island (see paragraph 2.2.1).

Several reports are available on stone artefacts from pre-Columbian sites in the Caribbean. They are especially numerous for pre-Ceramic sites (e.g. Davis 1974; Nicholson 1976). Fewer reports exist for the Ceramic period. Unfortunately, they often describe only small samples of lithic artefacts that were found during test-excavations, and they often lack essential drawings of the material (Knippenberg 1995:157). Most of the reports on stone tools focus on technology and morphology (e.g. Haag 1970; Walker 1980, 1985; Harris 1983; Allaire 1985; Knippenberg 1995; de Waal in press). Others are mainly occupied with functions of artefacts (e.g. Barbotin 1973; Drewett 1991). The present study focuses on manufacture technology and the morphology of stone artefacts. Since the sample is small, it is to be expected that no general insights are provided. This study of stone artefacts should thus be considered as a descriptive inventory of the lithic assemblage of the Petite Rivière site.

4.3.2 Provenance of the stone artefacts

As the Petite Rivière site did not provide much lithic artefacts, it was decided to include the material of both the 1984 and 1995 excavations in the analysis. The sieving and collecting strategies were rather similar. The 1984 artefacts were obtained after dry sieving on 5.0 mm mesh sieves, and the

1995 units were wet sieved over 2.0 and 2.8 mm mesh sieves, and then dry sieved over a 5.6 mm mesh sieve.

A total of 70 stone artefacts were included in the analysis (fig. 54, table 21). The 1995 fieldwork provided most of them (68.5%). In 1984, only 23 (31.5%) stone artefacts were found, mostly in unit F2. Of the 1995 units, units 1, 2, 12, and 13 provided most of the artefacts. The remaining units provided minor percentages. Almost all the stone artefacts were recovered from the upper layer of the units, which contained the densest artefact concentration. Only one stone artefact, however, was recovered from the second layer in unit 3. A total of two artefacts were found in the third layer of unit 11, and two others in the third layer of unit 4.

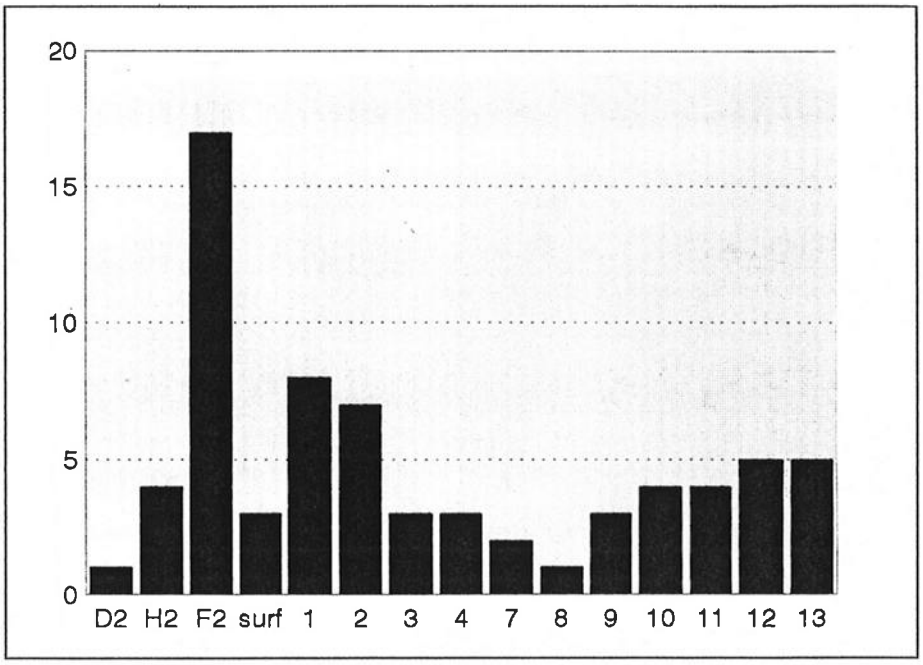


Figure 54. Petite Rivière stone artefacts per unit

unit	N	%	unit	N	%	unit	N	%
1984			1	8	11.4	9	3	4.3
D2	1	1.4	2	7	10.0	10	4	5.7
H2	4	5.7	3	3	4.3	11	4	5.7
F2	17	24.4	4	3	4.3	12	5	7.1
1995			7	2	2.9	13	5	7.1
surface	3	4.3	8	1	1.4	total	70	100.0

Table 21. Petite Rivière stone artefacts from the 1984 and 1995 units

4.3.3 Analysis of the stone artefacts[45]

4.3.3.1 Introduction

The objective of this study is to make a descriptive inventory of the Petite Rivière lithic assemblage. The stone artefacts were described with the help of a description form. Several variables were recorded, such as findnumber, identification of the rocktype (based on macroscopic characteristics), dimensions (mm), weight (g), presence of cortex, presence of weathered surfaces, presumed artefact type, presence of use-wear, and descriptions of technological features. For flint artefacts, some additional variables were recorded, such as presence of a cone of percussion, bulb of force, conchoidal fracture marks on the bulb, and butt. Finally, a description, based on macroscopic characteristics, was made of the structure and the texture of the flint flakes, and of their colours.

4.3.3.2 Rocktypes identified at Petite Rivière

Table 22 presents the numbers and percentages of raw materials of the stone tools per excavation unit. Most stone artefacts (32.9%) were made of basalt. Flint artefacts were also well represented (27.1%). An other important raw material is sandstone (15.7%). For six (8.6%) artefacts the rocktype could not be identified. Other rocktypes occurred less abundantly, such as limestone (2.9%), pumice (1.4%), diorite (4.3%), radiolite (2.9%), quartz (1.4%), granite (1.4%), and quartzite (1.4%).

rocktype	N	%	rocktype	N	%
limestone	2	2.9	radiolite	2	2.9
pumice	1	1.4	quartz	1	1.4
basalt	23	32.9	granite	1	1.4
flint	19	27.1	quartzite	1	1.4
sandstone	11	15.7	unidentified	6	8.6
diorite	3	4.3	total	70	100.0

Table 22. Petite Rivière stone raw materials

[45] Based on Knippenberg (1995).

Basalt, pumice, diorite, granite, and quartz are volcanic rocks that developed as a result of the coagulation of liquid rock mass. Basalt and pumice are finely structured because this process took place on the surface of the earth, as a result of which the magma cooled down rapidly. Diorite, granite and quartz originated through the coagulation of magma deep under the surface of the earth. The structure of these rocks is rougher, which renders them suitable for grinding purposes.

Sandstone, radiolite, limestone, and flint are sedimentary rocks. They consist of different layers and sometimes they have fossil inclusions. One of the most common sedimentary rocks is sandstone. Sandstone consists of quartz sand and it has a rough structure. Therefore it suits grinding purposes. An other sedimentary rock is radiolite. Radiolite consists of quartz, radiolarian skeletons and clay minerals. It is rich in silica and it produces sharp, concave flakes. It was often used for the manufacture of axes, e.g at the Hope Estate site on St. Martin (de Waal in press). Unfortunately, it breaks easily. Waterworn radiolite surfaces are smooth and could serve as polishing stones for pottery. A third sedimentary rocktype is limestone, which consists of finely structured calcite. Fossils might be included and their quantity and dimensions determine the texture of the rock. The last sedimentary rock found at Petite Rivière is flint, which is a siliceous material that produces sharp, concave flakes.

Quartzite is a layered metamorphic sandstone which consists of quartz granules. Its texture is moderately grained, while the structure is massif. Quartzite is very hard and therefore it is suited for the manufacture of axes. However, the Petite Rivière specimen includes quartz veins which weaken the strong and hard structure of the rock considerably.

4.3.3.3 Availability of raw materials at La Désirade

All the raw materials of the stone artefacts occur naturally at La Désirade. Most of them even occur in the near surroundings of the site. The hard volcanic rocks, such as basalt, pumice, diorite, quartz, and granite, can be found in the volcanic basement complex of the island. This complex surfaces in the eastern part of the island, and north of the site. Volcanic rocks are easy to obtain at La Désirade. Sedimentary rocks, such as limestone, sandstone, flint, and radiolite cover the volcanic basement. They can be found everywhere on the island. Metamorphic quartzite deposits are known to be located near Grande Anse and Pointe du Désert, which is at the western part of the island. This location is not very near the site, but only one artefact was found that had been made of this material.

4.3.3.4 Stone artefacts identified at Petite Rivière

Different types of stone artefacts were distinguished, such as waterworn pebbles, grinding stones, pebbles, rubbing stones, polishing stones, preforms (of an axe and a bead), flakes, a flaked core, a flake tool, beads, and zemis[46] (figs. 55-58, tables 23-24).

artefact type	N	%	artefact type	N	%
waterworn pebble	22	31.1	flaked core	1	1.4
grinding stone	9	12.9	flake tool	1	1.4
pebble	6	8.6	bead	2	2.9
rubbing stone	1	1.4	zemi	2	2.9
polishing stone	2	2.9	unidentified	5	7.1
preform	2	2.9	total	70	100.0
flake	17	24.3			

Table 23. Petite Rivière stone artefact types

A total of 22 (31.1%) *waterworn pebbles* were found. Most of them (72.7%) are from basalt. Others are from radiolite (9.1%) and an unidentified raw material (18.2%). The rocktype of waterworn pebbles is difficult to analyse geologically, because waterworn surfaces hinder the visibility of grainsize and types of grains (Knippenberg 1995:99). Waterworn pebbles were not worked as their surfaces had been smoothed and polished naturally. However, they do not occur naturally at the site. They might have been gathered in the gully next to the site (see paragraph 3.2). The waterworn pebbles are rather small. Their lengths range between 6 and 56 mm, their widths between 3 and 36 mm, their thicknesses between 8 and 30 mm, and their weights are between 0.5 and 64.0 g. Some of them might have been used as polishing stones, that were used to smooth and polish pottery surfaces in order to make them stronger and to give them a brilliant lustre. Longterm use as polishing stone results in the presence of use-wear in the form of long parallel striations. Only one specimen shows this use-wear. An other specimen has a pitted surface which resembles hammering use-wear (fig. 56a, page 113). For the other waterworn pebbles the function remains unknown. The reason for deposition is not clear, as they are not broken or damaged. Possibly the value of these stones was considered low, as they could be found nearby, and were they disposed of

46 Zemis (three-pointed objects) are considered to be the predecessors of the large zemis from stone, wood or even cotton, of the Tainos of the Greater Antilles. Zemis are believed to represent the divine forces of nature (Hoogland 1996).

after having been used. A short-term use also explains the lack of use-wear on the surfaces.

Pebbles were represented by six (8.6%) specimens in the sample. They are all from basalt. They are similar to the waterworn pebbles, except for that their surfaces are less smoothed. They have not been worked, and they do not occur naturally on the site. They are rather small. Their lengths range between 16 and 27 mm, their widths between 12 and 22 mm, their thicknesses between 7 and 17 mm, and their weights are between 0.5 and 8 g. The function of these artefacts is not known. Their rough surfaces might have been used for grinding or rubbing purposes.

A total of nine (12.9%) *grinding stones* (fig. 56b, page 113) were found. Most of them are from sandstone (66.7%). The other grinding stones consist of basalt (11.1%), diorite (11.1%), and granite (11.1%). These rocktypes have a natural abrasive structure. This structure is smoothed by repeated use but it can easily be roughened. Grinding use-wear consists of partially smoothed or hollowed surfaces. This was only found on a few specimens. Grinding implements were not extensively worked. They were simply cut out of abrasive rocks and they were probably formed during grinding activities. They do not have standardized forms. The dimensions of the different grinding implements vary considerably. Their lengths range between 23 and 192 mm, their widths between 12 and 145 mm, their thicknesses between 8 and 60 mm, and their weights are between 4 and 1985 g. As for their functions, grinding stones can be divided in 'manos' and 'metates'. Metates have flat or concave surfaces that were used as underlying surface for grinding activities. Manos are mortars that were used for grinding on a metate. Most of the Petite Rivière grinding stones probably functioned as manos. Grinding stones are known to have been employed for pounding cassava and other vegetable foods. They might also have been used to prepare fibres and to grind pigment (Joyce 1973:240). The Petite Rivière grinding stones had not been smoothed very much. Thus, they will not have been in use for long. They were probably not considered to be valuable. Not much effort had been put into their manufacture, and they might have been discarded after use.

A total of 17 (24.3%) *flakes* (fig. 57b, page 114) were found, which are all from flint. Their dimensions vary considerably. Their lengths range between 13 and 28 mm, their widths between 7 and 27 mm, their thicknesses between 1 and 18 mm, and their weights are between 0.2 and 4 g. Differences were present in the colour, structure and purity of the flint. One group consisted of fine-grained flint flakes without macroscopically visible fossils. The colours in this group are between beige, light greyish beige, beige with (reddish-)brown, and dark greyish-brown. A total of nine flakes belonged to this group. An other group has a fine-grained structure, with some inclusions. The colours of this group range between beige, beige with orange-brown, and dark grey with black. A total of three flakes belonged to this group. The last group of flakes is characterized by a coarser grain-size and inclusions in the flint matrix. The colours in this group range between beige, beige-brown, reddish-brown with greyish, and dark grey. A total of six flakes belonged to this group. Several manufacturing phases could be distinguished (Knippenberg1995:100-101).

First, the raw material had to be selected and acquired. The types of flint that were found are known to occur on the eastern part of the island. The second phase consists of preparation and core reduction (Walker 1980). The absence of cortex on the outer surfaces seems to indicate that primary reduction of the flint nodules did not take place at the site. It was probably done at the resource area[47]. The occurrence of both flint cores and flakes might suggest local flint knapping. At Petite Rivière, however, only one flaked core has been found, while flakes are more abundant. This suggests that flakes were produced at the resource area and then taken to the site where they were used. Because of their thin and sharp edges, flint flakes are suited for cutting, scraping, and drilling activities. They might have been used to process fish, work shell and wood, and vegetable foods such as manioc. A total of eight flakes have a bulb of force, and most of them also have conchoidal fracture marks. Only two of the flakes have a cone of percussion, while only one flake has a butt. The presence of pronounced bulbs of force might suggest freehand and hard percussion (Walker 1985:184). The flakes without bulb of percussion and butt might have been made through indirect or soft percussion. At Petite Rivière, the flake technology resulted in an amorphous set of small flakes which indicates that the method of flaking was non-systematic. No standardized tool-shapes and no signs of intentional retouch were found. The objective of the manufacture of the flakes seemed to have been more the production of suitable working edges rather than the manufacture of specific tool-shapes.

Other artefact types were represented by lower numbers. Only one (1.4%) *flaked core* of flint was found (fig. 57a, page 114). It belongs to the roughly grained flint type with macroscopically visible inclusions. Its colour is dark grey and beige-brown. It is the largest of the flint artefacts with its dimensions of 58x38x18 mm. Its weight is 32 g. It served for the removal of several flakes. Exhaustion of the material to produce more flakes might have been the reason for its discard. Only one (1.4%) *flake tool* of flint was found. It belongs to the finegrained flint type with inclusions. The colour of this tool is beige with orange-brown. Its dimensions are 44x39x9 mm, and its weight is 12 g. The presence of a pronounced bulb of force and conchoidal fracture marks suggest that it probably was made by hard and free-hand percussion. This artefact might have been used as a cutting and scraping instrument. As this artefact and the other flint flakes are still sharp, the reason for their discard is unknown. Only one (1.4%) *rubbing stone* was found. This specimen is from pumice, which makes it suitable for rubbing or very soft grinding purposes. Its dimensions are 24x20x6 mm, and its weight is 2 g. It has not been worked. It probably served for short-term use and was discarded afterwards. A total of two (2.9%) *polishing stones* were found. One of them was from limestone (50%) and the other from a very soft and finely structured sandstone (50%).

47 Special activity areas for the manufacture of stone tools might have been situated at the sites of Pointe Doublé and Morne Baie-Mahault (Bodu 1984). Unfortunately, no C14 dates are available for these sites (see also appendix 1).

Their dimensions are 25x23x15 mm and 81x42x18 mm. Their weights are 10 and 64 g. They had not been worked, but their very smooth and soft surfaces demonstrate their use as polishing stone. They might have been used to polish artefacts from shell, wood, animal bone, or stone.

Most of the stone artefacts were probably tools. Some artefacts, however, have a more decorative function. For example, two (2.9%) *beads* were found. It was impossible to determine their raw materials, as a result of their limited dimensions and their worked and smoothed surfaces. The smallest bead has a diameter of 4 mm and a thickness of 1 mm. Its weight is 0.2 g. The larger specimen is a cylindrical bead with a length of 17 mm and a diameter of 8 mm (fig. 57c, page 114). It was perforated through the length of the bead and through the upper part of the diameter. The bead had been carefully smoothed and polished. No products or other traces of bead production were identified, which (not regarding the small size of the sample) might suggest that finished beads were brought to the site. Finally, a total of two (2.9%) *zemis* (fig. 57d, page 114) were found. One of them is from limestone with marine skeletons included and the other from very soft sandstone. The dimensions of the limestone zemi are 58x42x23 mm, with a weight of 52 g. The sandstone specimen measures 63x34x22 mm, with a weight of 48 g. The zemis had been carefully finished by soft grinding or polishing. The zemis had no bases. Both of them have a shallow deepening at the bottom. Neither the beads, nor the zemis had been damaged and therefore loss is proposed as the reason of discard.

For the preforms and for some other stone artefacts it proved to be rather difficult to identify the artefact type. A total of two (2.9%) *preforms* were found. One is an axe-like object (fig. 58a, page 115), which had been partially outlined by a flaking technique out of quartzite with quartz veins. The surfaces had not yet been ground or smoothed. Its dimensions are 140x60x40 mm, and its weight is 618 g. Axes do often occur in archaeological sites in the Caribbean. As a function, heavy wood working activities are often suggested. At the Petite Rivière site, however, only this non-finished specimen was found. The other preform probably represents the rough outline of a bead or a pendant-like object (fig. 58b, page 115). The dimensions for this specimen are 36x29x27 mm with a weight of 54 g. It had been cut out of quartz, and its surfaces had been smoothed and polished. A modest beginning had been made for a small perforation. The surface of the preform is slightly damaged. This may have been the reason for its discard. Furthermore, a total of five (7.1%) *unidentified artefacts* were found. Their lengths vary between 45 and 77 mm, their widths between 27 and 48 mm, their thicknesses between 12 and 32 mm, and their weights are between 24 and 170 g. These objects consisted of sandstone (60%) and diorite (40%).

4.3.4 Conclusion

In the Petite Rivière sample, several types of stone artefacts were represented. Waterworn pebbles are the most abundantly represented among them (72.7%), followed by flakes, grinding stones, pebbles, and unidentified artefacts. Rubbing stones, polishing stones, flake cores, flake tools, zemis, and beads are represented by minor percentages.

La Désirade has locally available hard rocks of volcanic, sedimentary and metamorphic origin, that are suited for the manufacture of tools and ornaments. The raw materials that were encountered in the sample consist of basalt, pumice, diorite, quartz, granite, limestone, flint, sandstone, radiolite, and quartzite. They can be easily obtained in the vicinity of the site, and they were probably chosen as a raw material because of their characteristic hardness or roughness, or their aesthetic appearance. Basalt had been used for (waterworn) pebbles and grinding stones, because of its smooth and fine structure. Sandstone specimens were found in the form of grinding stones, a polishing stone, a zemi, and unidentified objects. As a result of its rough quartz sand structure, sandstone is very suited for grinding purposes, while smoother sandstones can be used for polishing activities. Limestone had been used for a polishing stone and for a zemi. Limestone is finely structured and rather soft, which makes it easy to be polished and suitable for polishing activities. Flint had been used for the manufacture of flakes, a flake core and a flake tool. Flint consists of siliceous material, which produces sharp, concave flakes. It is easily worked. Flakes can be used as tools that serve a range of different purposes, such as cutting, scraping, drilling and puncturing activities. The material is very durable and easily resharpened. Other raw materials had been used in minor percentages.

Due to the small sample studied, not much information on manufacture technology could be acquired. The Petite Rivière lithic assemblage can be considered as poor. For example, the flake technique does not seem to have been very elaborate. From the Suazoid Macabou site on Martinique, a more advanced technology was reported. It had been used to flake cores with a free-hand and better controlled percussion (Allaire 1985:309). The flaking technology is rather similar to the one that was distinguished at the pre-Ceramic sites of Norman Estate-1 and -2 on St. Martin (Knippenberg 1995:105). The aim of this flaking technology was to produce flakes which could be randomly used as "tools in a non-systematic, non-preferential manner"[48]. The other tools had not been worked precisely either. They had only been roughly formed. The zemis are the most carefully smoothed and finished artefacts. Since the manufacture technique of the stone tools is not very

[48] Bartone R.N. and J.G. Crock, 1993, Flaked stone industry at the early Saladoid Trants site, Montserrat, West Indies. In: Proceedings of the Fourteenth International Congress for Caribbean Archaeology.

elaborate, and suitable raw materials abundantly occur in the immediate surroundings of the site, the artefacts can be expected to have been disposed of after short-term use.

The Petite Rivière tool types and their manufacturing technologies are common from most excavations that provide stone tools. Similar axe-forms (although finished axes have not been found at the Petite Rivière site), polishing-rubbing- and grinding instruments have been found at pre-Columbian sites on Barbados. Locally available sandstones had been used here since hard volcanic rock does not occur naturally on Barbados (Drewett 1991). The lithic technology for Ceramic sites in the Caribbean is known to be not very elaborate (de Waal in press), but the lithic assemblage of the Petite Rivière site seems to be even more poor than that of other Ceramic sites.

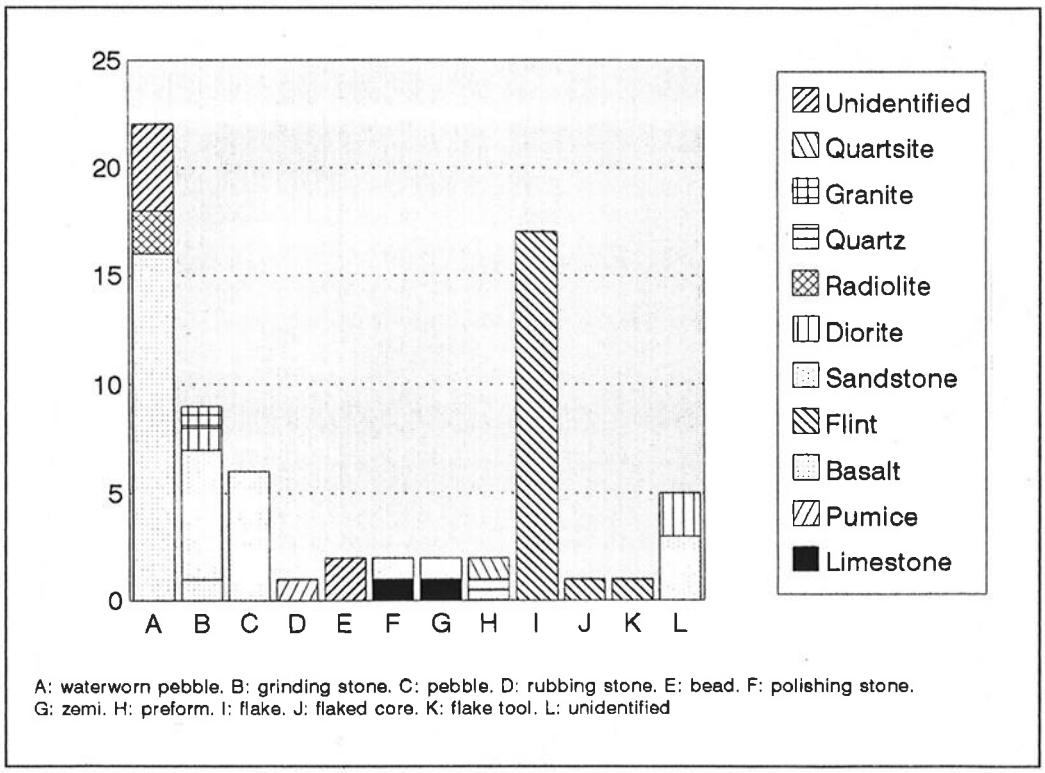


Figure 55. Raw materials used for Petite Rivière stone artefacts

	lime-stone	pumice	basalt	flint	sand-stone	diorite	radio-lite	quartz	gra-nite	quartzite	unident	total
A			16				2				4	22
%			72.7				9.1				18.2	100
B			1		6	1			1			9
%			11.1		66.6	11.1			11.1			100
C			6									6
%			100									100
D		1										1
%		100										100
E	1				1							2
%	50				50							100
F								1		1		2
%								50		50		100
G				17								17
%				100								100
H				1								1
%				100								100
I				1								1
%				100								100
J											2	2
%											100	100
K	1				1							2
%	50				50							100
L					3	2						5
%					60	40						100
total	2	1	23	19	11	3	2	6	1	1	1	70
%	2.9	1.4	32.9	27.1	15.7	4.3	2.9	8.6	1.4	1.4	1.4	100

Table 24. Raw materials used for the manufacture of Petite Rivière stone artefacts.

A: waterworn pebble
B: grinding stone
C: pebble
D: rubbing stone
E: polishing stone
F: preform
G: flake
H: flaked core
I: flake tool
J: bead
K: zemi
L: unidentified

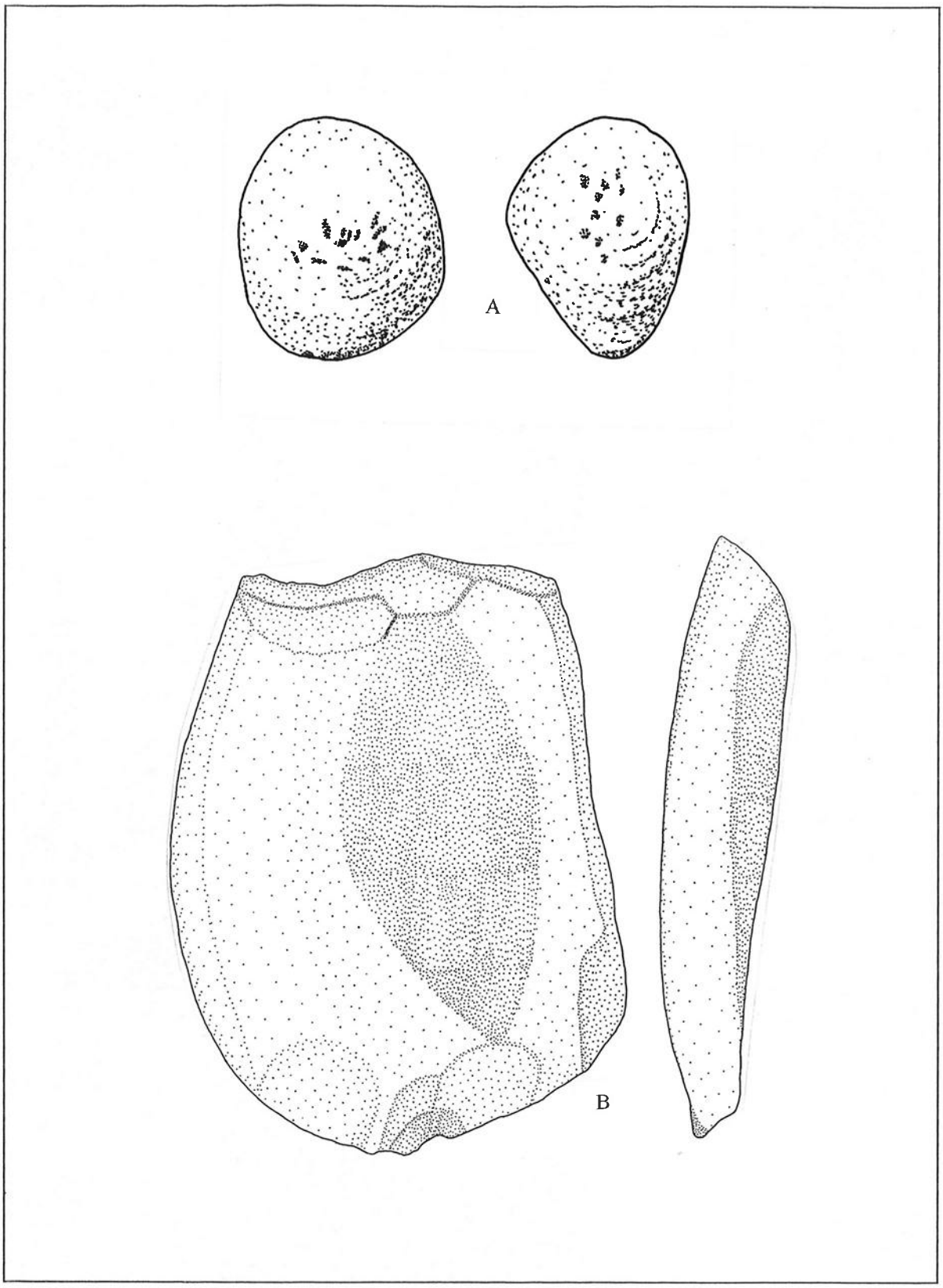


Figure 56. Petite Rivière stone artefacts: A. basalt waterworn pebble with hammering use-wear (scale 1:2); B. basalt grinding stone (scale 1:4)

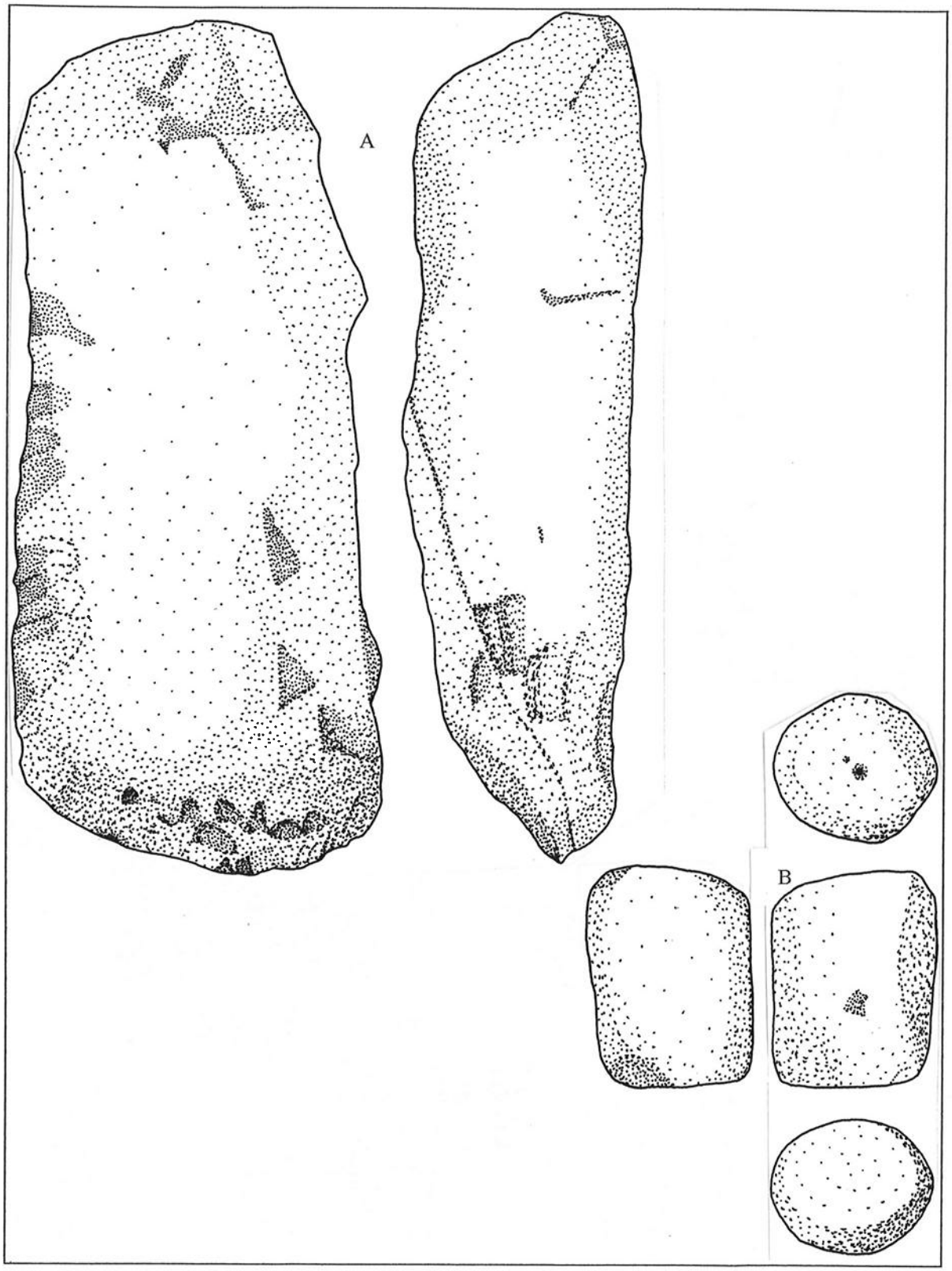


Figure 58. Petite Rivière stone artefacts (scale 1:1): A. preform of a quartzite axe; B. preform of a quartz bead

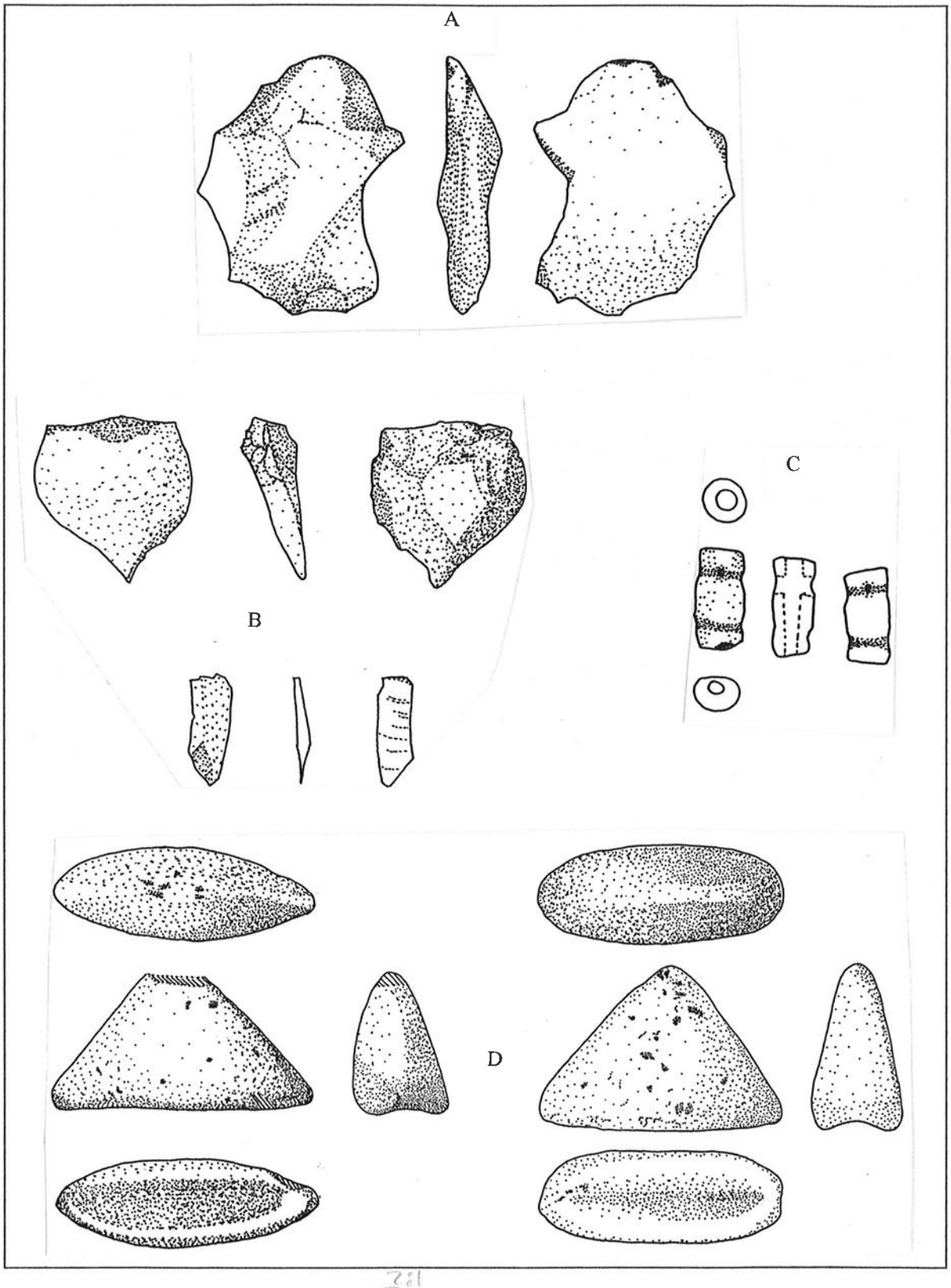


Figure 57. Petite Rivière stone artefacts (scale 1:2; except C. scale 1:1): A. flint flaked core; B. flint flakes; C. bead of an unidentified rocktype; D. zemis of sandstone (left) and limestone (right)

4.4 SHELL FOOD REMAINS AND ARTEFACTS

4.4.1 Introduction

Shellfish has been a major foodsource for coastal pre-Columbian Amerindians and shells were also often used as raw material for the manufacture of tools and ornaments. At many pre-Columbian sites, the debris of the shellfish consumed has formed a shell-midden. At Petite Rivière shellfish constitutes an important part of the excavated material.

4.4.2 Provenance of the shell food remains and artefacts

The analysed shell food remains were all found during the 1995 fieldwork. Those found in 1984 have not been included in the analysis, as it was not certain that all the shell fragments had been collected. Moreover, no great differences were expected between the 1984 and 1995 material. The studied shell artefacts were found during both the 1984 and 1995 campaigns. This was done because hardly any shell artefacts were found during the 1995 campaign, and because they can be expected to have been collected more accurately than the shell food remains in 1984. The shell material was found uniquely in the upper layer of the units. The shell material was recovered by sieving over 2.8 mm and 2.0 mm mesh sieves, but only the food remains left over after sieving over 5.6 mm mesh sieves were analysed. The artefacts also include material from the 2.8 and 2.0 mm sieves.

A total of 33,665 g of shell food remains was studied. Of the units excavated in 1995, units 1, 4, 11, 12, and 13 provided most of the shell food remains, representing respectively 12.5%, 13.3%, 19.8%, 11.8%, and 15.0% of the total sample (table 25). The remaining units provided minor percentages. Unit 10 (7.4%) was located in a rather dense find concentration but it produced almost as few shell remains as did unit 2 (7.8%), which was more removed from this concentration.

unit	total wght (g)	%	compl. wght (g)	%	indiv. wght (g)	%	frag. wght (g)	%
1	4223	12.5	8	0.6	1817	12.1	2398	12.2
2	2482	7.8	9	0.7	568	3.8	1904	9.7
3	1324	3.9	4	0.3	173	1.2	1148	5.8
4	4509	13.3	357	25.7	4127	27.6	1501	7.6
6	68	0.2	0	0.0	3	0.0	65	0.3
7	1014	3.0	8	0.6	80	0.5	926	4.7
8	300	0.9	114	8.2	118	0.8	1008	5.1
9	1484	4.4	14	1.0	378	2.5	1091	5.5
10	2521	7.4	181	13.0	476	3.2	1864	9.4
11	6688	19.8	366	26.3	3869	25.8	2453	12.4
12	3997	11.8	224	16.1	1557	10.4	2216	11.3
13	5055	15.0	106	7.5	1816	12.1	3163	16.0
total	33665	100.0	1391	100.0	14982	100.0	19737	100.0

Table 25. Weights (g) and percentages of Petite Rivière shell food remains in totals, complete shells, individuals[49], and fragments per unit

In order to determine the degree of fragmentation of the material, the counts and the percentages of the complete shells represented per unit should be regarded (table 26). These data demonstrate that 25.0% of the complete shells was found in unit 4, and that units 11, 12, and 13 produced respectively 12.5%, 12.2%, and 18.3%. These units also contain the largest numbers of individuals, 15.1%, 13.8%, 11.7%, and 15.9% respectively. The other units consisted of more fragmented material. Due to great differences in weight between shell species, large and heavy species, such as *Cittarium pica* and *Strombus gigas*, might be overrepresented. A more precise assessment of the different species that contributed to the shellfish component of the diet can be made through the count of 'Minimum Number of Individuals' (MNI). This count combines the counts of complete shells and individuals. The largest MNI's were found in units 1, 2, 4, 10, 11, 12, and 13. Thus, units 1, 2, 4, 11, 12, and 13 appear to represent the largest quantity and the best quality of shell remains, whereas the remaining units are of minor importance.

[49] Complete shells are not damaged at all, while individuals are not complete but still recognizable as an individual, for instance when a complete spiral is present.

unit	complete (N)	%	individual (N)	%	MNI	%
1	11	3.7	64	8.4	75	7.1
2	20	6.8	80	10.5	100	9.5
3	13	4.4	36	4.7	49	4.6
4	74	25.0	115	15.1	189	17.9
6	0	0.0	4	0.5	4	0.8
7	8	2.7	23	3.0	31	2.7
8	4	1.4	29	3.8	33	3.1
9	16	5.2	28	3.7	44	4.0
10	23	7.8	68	8.9	91	8.6
11	37	12.5	105	13.8	142	13.4
12	36	12.2	89	11.7	125	11.8
13	54	18.3	121	15.9	175	16.5
total	296	100.0	762	100.0	1058	100.0

Table 26. Counts of complete shells, individuals, and Minimum Numbers of Individuals (MNI) at Petite Rivière

4.4.3 Analysis of the shell food remains

4.4.3.1 Introduction

The shell food remains were classified on a description form[50] and a mollusc reference collection. The form lists 69 of the most common shellfish species in the Caribbean, including 52 gastropods, 13 bivalves, three chiton species, and one landsnail species. The complete shells, and the 'Minimum Numbers of Individuals', were counted and weighed per species. Finally, the weight of the fragments and the total weight was recorded per species.

50 The form was made by A. Brokke and R. Jansen in order to standardize the description of the shell food remains at the 1993 Hope Estate excavations (St. Martin).

4.4.3.2 Petite Rivière shell species[51]

A total of five major classes of shellfish occur in the Caribbean Sea, but only three of them were represented in the Petite Rivière shell food remains (fig. 59, page 121; table 27, page 123). About 75% of the known West Indian marine shells belong to the class of gastropoda, or snails, that live in fresh water and on land. The members in this class have usually single spiral shells. Many gastropods have an operculum, which is a horny or calcareous appendage with which the animal can close the entrance of the shell.

The second class is formed by pelecypoda, or bivalves, that live in the sea and in fresh water. The shells of this class are composed of paired valves which are joined by a hinge at one end and which can be closed by the mollusc. About 20% of the known West Indian shells belong to this class.

The last class of shells which occurs among the shell food remains at Petite Rivière are amphineura, or chitons, which mainly occur in the intertidal zone. A chiton's shell consists of eight interlocking V-shaped plates bound together by a leathery peripheral girdle. This class consists of two distinct groups. One includes the familiar chitons, while the other includes a group of molluscs without shells. Archaeologically, only the first group is important.

Gastropoda

Most of the shell species found at Petite Rivière belong to the class of the gastropoda, in which *Cittarium pica* (Linné 1758) is outnumbering all the other species. A total of 200 MNI's were counted (18.9%). *Cittarium pica*, with diameters ranging from 5 to 10 cm, is the most common of the larger West Indian gastropods. It occurs in great numbers on and under rocks in intertidal areas, usually exposed to the open sea. The very large specimens are sometimes found in deeper water. The shell material of the Cittarium pica is hardly used for the fabrication of tools or ornaments, because of its bladdery structure. The shells that are found in archaeological context are the left-overs from food processing. Some of these shells, however, might also have been transported to the site by hermit crabs (Taverne and Versteeg 1992).

An other species that occurs rather abundant at Petite Rivière is *Tegula* sp. *Tegula substriata* is present with 36 MNI (3.4%), and *Tegula excavata* (Lamarck 1822) is present with 113 MNI (10.7%). The total weight of this species, however, is rather modest due to the limited dimensions of the shells. The shells measure only 2.5 cm. These limited dimensions make it questionable whether the shells have been used as a food source. This is also the case with *Nerita* sp. It is also possible that they were brought to the site on other shells. It should not be forgotten, however, that

[51] Descriptions are based on Humfrey (1975:17-25).

the food value of several small shellfishes might be comparable to that of larger ones. They are not thought to have been the major part of the shellfish component of the diet, but, as a result of their easy collecting and their occurrence in large numbers, they might have made an important supplement to the diet. *Tegula excavata* is very common on and under rocks in the lower intertidal areas. It prefers areas directly exposed to the open sea.

Nerita sp. is present with 143 MNI (13.5%). The shells have modest dimensions. *Nerita peloronta* (Linné 1758) is about 2.5 to 3.8 cm long, *Nerita versicolor* (Gmelin 1791) about 2 cm, and *Nerita tessellata* (Gmelin 1791) about 1.2 to 2 cm. *Nerita versicolor* outnumbers the other two species. *Nerita tesselata* only occurs with two MNI. *Nerita* sp. are abundant on rocks just above the high tide mark, and in rocky areas exposed to the open sea. They are easy to collect which renders them interesting to exploit. Probably, this characteristic can be applied on all the small species that were found.

A total MNI of 126 (11.9%) *Nodilittorina tuberculata* (Menke 1828) were found. The dimensions of this species are also modest, about 1.2 to 1.9 cm long. It occurs on rocks just above the tide mark.

Tectarius muricatus (Linné 1758) was found with an MNI of 76 (7.2%). Although its dimensions are modest, about 1.9 to 2.5 cm, it might have been important as it is one of the most common and most accessible gastropods. It is abundant on rocks and trees from 0.3 to 1 m above the high tide mark.

Only 16 MNI (1.5%) of *Strombus gigas* (Linné 1758) could be identified. It is the largest species that is usually found, with a length of about 12.7 to 31 cm. Therefore, it may have been a very attractive food source. Nowadays, it is still extensively used as bait and food, and in some areas it may be quite rare as a result of overexploitation. It seems plausible that the Amerindians were able to find it in shallow waters close to the shore. According to Keegan (1982[b]:82), pre-Columbian inhabitants might have had an inexhaustible supply, especially since breeding and spawning pairs are often found in water below ten meters. The habitat of the *Strombus gigas* is in seagrass beds in shallow waters, normally about 0.3 to 2 m. They can be found upto depths of 60 m. The snail can be obtained by making a hole in the shell and cutting the attaching muscle, or by heating the shell and thus forcing the animal from its shell. The meat of *Strombus gigas* is an excellent source of protein, and it can be prepared in several ways. It can be eaten raw or cooked, or it can be dried for future consumption (Keegan 1982[b]:82-84). It has been suggested that the animals were removed at the beach, while the heavy shells were left on the coast, except for the useful parts of the shell such as the lip (Taverne and Versteeg 1992:90). Therefore, it might be possible that *Strombus gigas* food remains are underrepresented. At the Petite Rivière site, however, only a distance of a few meters had to be made.

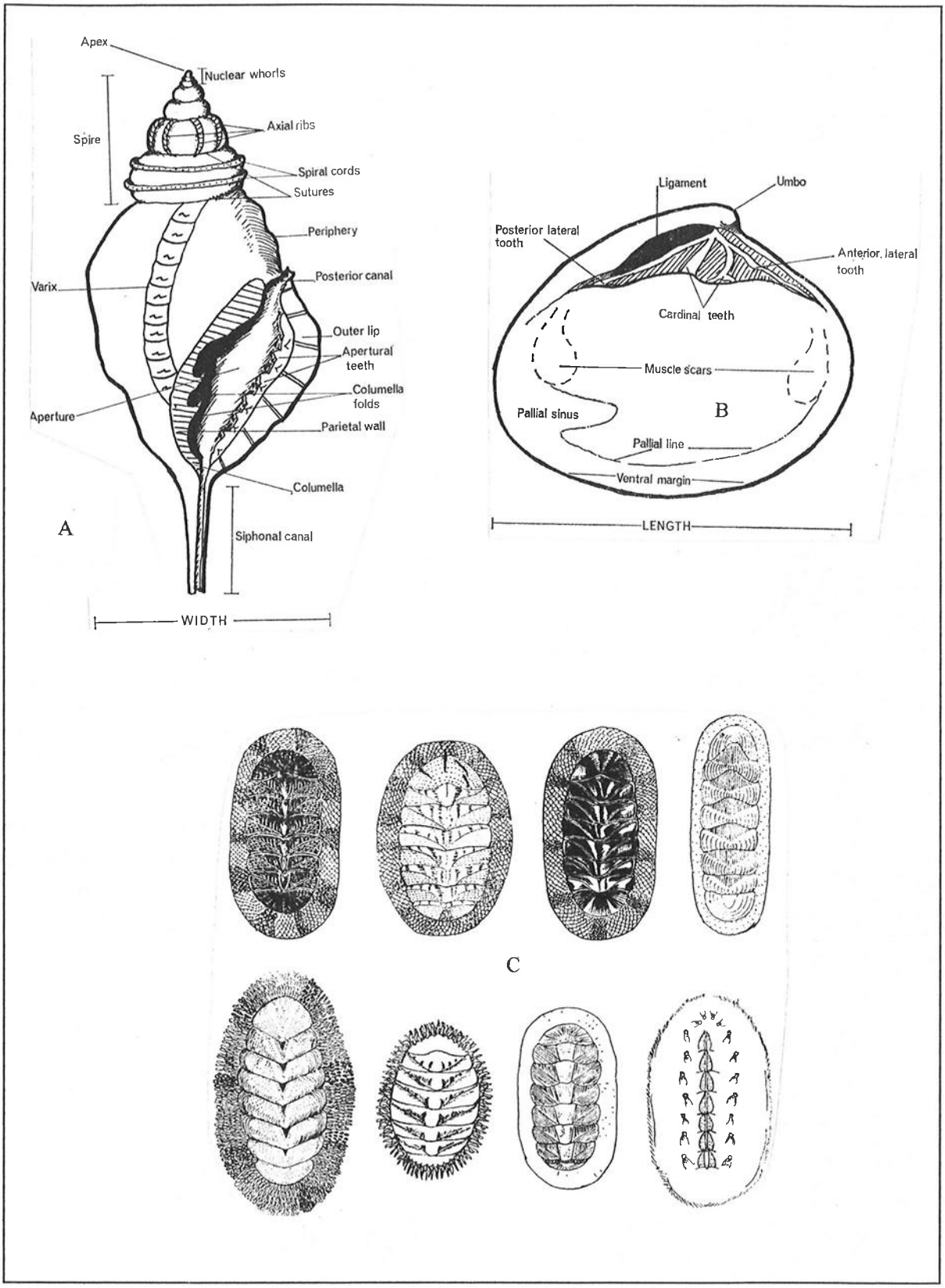


Figure 59. West Indian shells: A. gastropod shell; B. bivalve shell; C. chitons (After Humfrey 1975)

Most of the remaining gastropoda species are small and occur in modest quantities, their MNI's making up less than 1% of the total sample. This seems to point to an incidental collection of these species. Among these are *Fissurella* sp., *Acmaea* sp., *Astrea* sp., *Planaxis nucleus* (Bruguière 1789), *Cerithium litteratum* (Born 1778), *Strombus ranimus* (Gmelin 1791), *Cypraea* sp., *Cassis flammea* (Linné 1758), *Cypraecassis testiculus* (Linné 1758), *Charonia variegata* (Lamarck 1816), *Tonna maculosa* (Dillwyn 1817), *Purpura patula* (Linné 1758), *Thais rustica* (Lamarck 1822), *Pisania pusio* (Linné 1758), *Leucozonia ocellata* (Gmelin 17910, *Oliva reticularis* (Lamarck 1811), *Olivella* sp., *Conus mus* (Hwass 1792), *Littorina* sp., and *Bursida* sp. They are common in the West Indies and easy to collect, most of them occurring on rocks exposed to the open sea in intertidal zones.

Land snails, occurring in the Petite Rivière sample with a total weight of 197 g (0.5%) were probably attracted to the midden and not collected on purpose. Their use as food source seems highly unlikely.

Bivalves

Among the Petite Rivière shell food remains, only five bivalve species were found, namely *Arca zebra* (Swainson 1883), *Codakia orbicularis* (Linné 1758), *Tellina radiata* (Linné 1758), *Tellina fausta/Arcopagia fausta* (Pulteney 1799), *Lucina* sp., and *Periglypta listera/Antigona listeri* (Gray 1838). All these species were found in minor quantities. The numbers of these species are so small that they probably did not contribute to the diet as an important food source. This might be explained as a result of preferences within the food economy. Their lengths range between 5 to 10 cm, thus their dimensions will not have been the reason for not having been collected intensively. They occur abundantly and they are not difficult to collect either, as their habitats are in shallow water. Most of them prefer muddy or sandy areas, except for *Arca zebra* which is attached to rocks.

Chitons

Chitons are abundant among the Petite Rivière shell food remains. A total of 253 MNI's (24.1%) could be identified. *Acanthopleura granulata* (Gmelin 1791) greatly outnumbers *Chiton tuberculatus* (Linné 1758) and *Chiton marmoratus* (Gmelin 1791). *Chiton* sp. are very common in the intertidal zone on and under rocks on rocky coasts. Their lengths range between 5 to 8 cm, which renders them a satisfiable food source.

species[52]	tot. wght	%	MNI	%	species	tot. wght	%	MNI	%
Fiss.nodosa	16	0.1	9	0.9	*Thais rus.*	1	<0.1	1	0.1
Fiss.nimbosa	4	<0.1	2	0.2	*Purp.pat.*	192	0.6	10	1.0
Acmaea antill.	3	<0.1	1	0.1	*Pis.pusio*	1	<0.1	1	0.1
Acmaea pust.	1	<0.1	3	0.3	*Leuc.ocel.*	1	<0.1	2	0.2
Citt.pica	23810	70.7	200	18.9	*Oliva ret.*	4	<0.1	4	0.4
Tegula exc.	408	1.2	113	10.7	*Conus mus*	17	0.1	12	1.1
Astr.caelata	5	<0.2			*Arca zebra*	1	<0.1		
Astr.tuber	67	0.2	8	0.8	*Cod.orbic.*	10	<0.1		
Nerita pelor.	2	<0.1	2	0.2	*Olivella*	1	<0.1	1	0.1
Nerita vers.	65	0.2	56	5.3	*Tell.radiata*	5	<0.2	3	0.3
Nerita tess.	75	0.2	85	8.0	*Lucina pec.*	25	0.1	1	0.1
Litt.angustior	3	<0.1	16	1.5	*Teg.substr.*	40	<0.1	36	3.4
Nodilitt tuber.	32	0.1	126	11.9	*Perigl list.*	4	<0.1		
Tect.muricatus	38	0.1	76	7.2	*Str.ranimus*	100	0.3	1	0.1
Planaxis nucl.	1	<0.1	1	0.1	*Tell.fausta*	9	<0.1	2	0.2
Cerithium litt.	1	<0.1	1	0.1	*Bursa gran.*	3	<0.1	1	0.1
Str.gigas	6001	17.8	16	1.5	*Tonna mac.*	1	<0.1		
Cypr.cinera	10	<0.1	2	0.2	*Chiton tub.*	125	0.4	36	3.4
Cypr.zebra	29	0.1	1	0.1	*Chiton mar.*	40	0.1	15	1.4
Cassis flam.	38	0.1	1	0.1	*Acanth.gran.*	2002	6.0	202	19.3
Cypraec. test.	58	0.2	4	0.4	*Drym.virg.*	197	0.5		
Charonia var.	59	0.2	2	0.2	total	33665	100.0	1058	100.0

Table 27. Total weight (g) and MNI represented per shell species at Petite Rivière

[52] The shell species occur in the same order as they are on the description form

4.4.3.3 Concluding remarks

In the preceding paragraphs, a proportional distribution was calculated by MNI per species in order to better understand the food economy. It may remain difficult to draw final conclusions on the exact percentual composition of the shellfish component of the diet, because part of the material (e.g. *Cittarium pica*) might have been brought to the site by hermit crabs. Moreover, the sample is limited. However, since these disadvantages can not be avoided for this study, the percentages of the various shellfish species are estimated on the basis of their MNI counts.

Regarding those percentages (fig. 60; table 28, page 125) it can be concluded that the main part (23.9%) of the Petite Rivière shell food remains consists of Chitons. Other major contributions were made by *Cittarium pica* (18.9%), *Tegula* sp. (14.1%), *Nerita* sp. (13.5%), *Nodilittorina tuberculata* (11.9%), and *Tectarius muricatus* (7.2%). Remarkably, *Strombus gigas* was only represented by 1.5%. Bivalves are also only a very minor component of the diet, although they are also thought to have occurred in the immediate surroundings of the site. These species can be easily collected in the Petite Rivière bay near the site. Selection among shell food resources seems to have taken place, as the species that must have been present in the surroundings of the Petite Rivière site, were not exploited with the same intension. The size of the shells does not seem to have been a criterion for selection as small species are rather abundant.

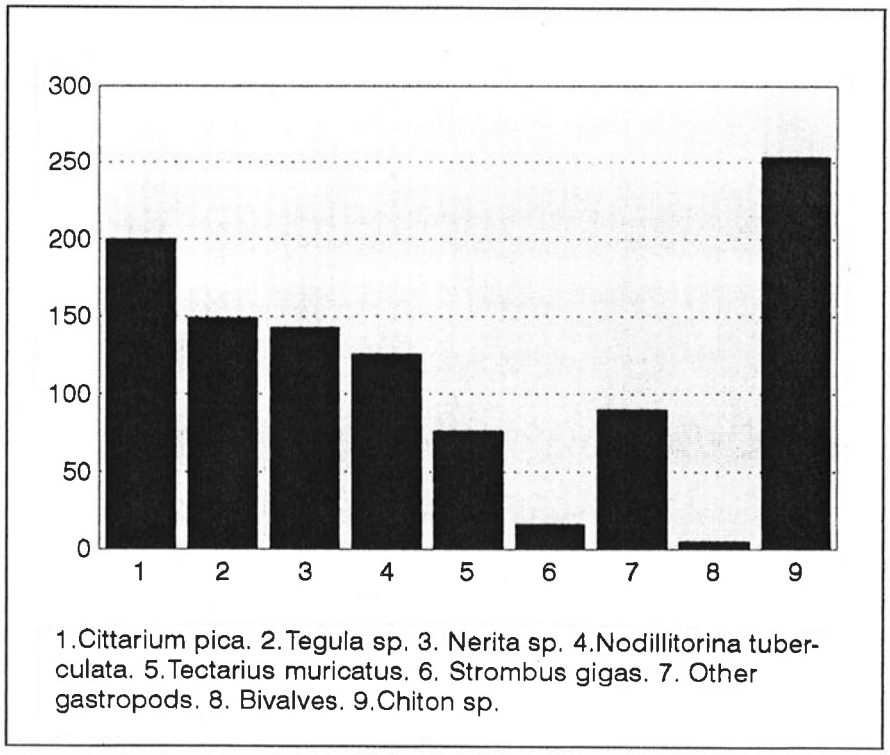


Figure 60. Petite Rivière shell food species (MNI)

species	MNI	%
Cittarium pica	200	18.9
Tegula sp.	149	14.1
Nerita sp.	143	13.5
Nodilittorina tuberculata	126	11.9
Tectarius muricatus	76	7.2
Strombus gigas	16	1.5
Other gastropods	90	8.5
Bivalves	5	0.5
Chiton sp.	253	23.9
Total	1058	100.0

Table 28. Petite Rivière shellfish components

4.4.4 Analysis of the shell artefacts

4.4.4.1 Introduction

Artefacts made out of shell are found in most pre-Columbian sites in the Caribbean. Shell provides a raw material that is very suited for the manufacture of tools and ornaments, because of the hardness, smoothness and beautiful colours of the material. Unfortunately, until now it has proved to be difficult to make regional cultural and/or chronological typologies for shell artefacts. Therefore, most reports on pre-Columbian shell artefacts (e.g. van der Steen 1992; Jansen in press) only describe the morphology and manufacturing technology of shell artefacts. The Petite Rivière shell artefacts, their quantity being rather limited and their provenance being not completely clear, can not contribute to the drafting of a regional shell typology either. Therefore, the objective of this study is to provide a morphological description.

4.4.4.2 Provenance of the shell artefacts

The artefacts were obtained during the 1984 and the 1995 excavations. The material from the 1984 excavations was sieved on 5.0 mm mesh sieves, while the 1995 material was sieved on 2.0 and 2.8 mm mesh sieves. Although the 1995 excavations produced hardly any shell artefacts, the fine sieving did provide some small beads that would have been lost by sieving on 5.0 mm mesh sieves. The 1984 and 1995 excavations yielded 39 shell artefacts (table 29). Many artefacts (30.8%) had been found on the surface of the site. A total of ten artefacts (25.6%) were found in unit F2, and five artefacts (12.8%) were found in unit D2. Units C2, E2, H2, and I2, and units 4, 12, and 13 provided minor numbers of shell artefacts.

unit	N	%	unit	N	%
surface	12	30.8	I2	2	5.1
C2	1	2.6	4	2	5.1
D2	5	12.8	12	1	2.6
E2	1	2.6	13	2	5.3
F2	10	25.6	total	39	100.0
H2	3	7.7			

Table 29. Petite Rivière shell artefacts per unit

4.4.4.3 Petite Rivière shell artefacts

Introduction

The Petite Rivière shell artefacts were divided in three main categories, which will be described below. These are the categories of shell tools (53.9%), shell ornaments (12.8%), and unidentified objects (33.3%). They can be sub-divided in different artefact types (figs. 61-64, table 30). Most common are axe-like tools (33.3 %), scrapers (15.4%), and beads (10.2%). The remaining artefact types, such as pointed tools, fish hooks, and zemis were represented by one specimen per category (2.6%).

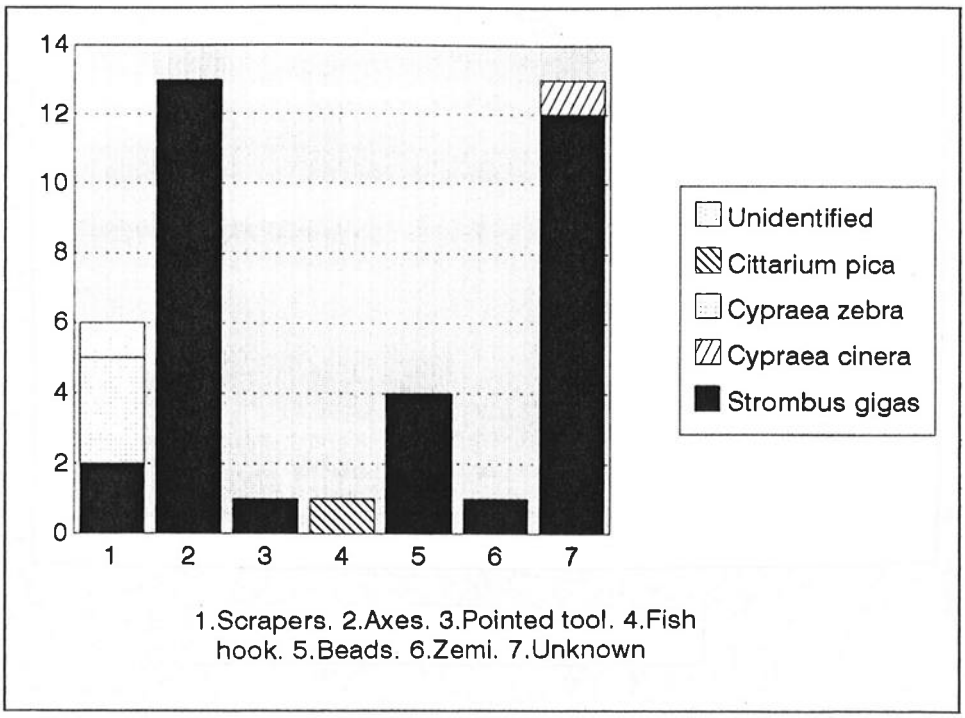


Figure 61. Petite Rivière shell artefacts

artefact type	N	%	artefact type	N	%
scrapers	6	15.4	beads	4	10.2
axes	13	33.3	zemi	1	2.6
pointed tool	1	2.6	unknown	13	33.3
fish hook	1	2.6	total	39	100.0

Table 30. Petite Rivière shell artefact categories

Shell tools

The 1984 excavations provided 13 axe-like artefacts (fig. 62, page 129). They were all made out of the lip of *Strombus gigas* shell. This is a homogeneous material and the thickest portion of the shell, and it is easy to collect and to shape. Axe-like artefacts can have various names, such as adzes, celts, chisels, and celt hammers, which all imply different functions. For the Petite Rivière *Strombus gigas* tools, the general name of 'axes' has been chosen since no use-wear analysis has been carried out. An axe is a tool with a cutting function, and therefore it needs a sharp, and rounded edge. It is hafted in such a way that its edge is parallel to the shaft (van der Steen 1992:100). For the Petite Rivière axes, some morphological differences can be distinguished. It is not clear whether those morphological differences can be attributed to functional differences. One morphological group of

five axes is characterized by their heavy and wide appearance, and by their rounded tops and butts. Only two of them were complete. In average, the dimensions of the complete axes are 125x54.5x17 mm. Their average weight is 197 g. They have been worked precisely, their edges are thin and smoothed, and their surfaces have been heavily polished. They might have been used as cutting and chopping tools. Use-wear, in fine and long striations perpendicular to the working edge is present. No hafting wear could be found. An other group of three axes is characterized by the long and small appearance of the axes, and their small and rounded tops and butts. One of them had been left unfinished. Their lengths range between 140 and 168 mm, their widths between 47 and 52 mm, and their thicknesses between 20 and 22 mm. Their weights are between 204 g and 252 g. The working edges of the two finished axes had been made thin and sharp, and the surfaces and edges had been smoothed and polished. The edges of the unfinished specimen had been left thick and irregular, and its surfaces were not smoothed and polished either. They may have been used as chisels. No use-wear or hafting wear could be found. The last category includes three axes that have a more or less rectangular working edge. Two of them are complete. One has a small and rounded top, while the other has a more or less rectangular top. Their average dimensions are 127.5x47.5x20.5 mm and their average weight is 212 g. Those artefacts have also been precisely worked and finished. The shape of the axes suggests that they were probably hafted. The damage at the working edges might have resulted from cutting activities. Finally, two unfinished specimens were found. They have been cut out of the lip of the shell, without being formed into their final shape. These specimens are rather heavy, weighing 396 and 272 g respectively. Their average dimensions are 153x62x29 mm and their average weight is 334 g. Their surfaces are rough and bladdery. Their functions can not be identified. Similar axes have been found at Chatham Midden on the Grenadines (Sutty 1978:fig. 8), at the Golden Rock site on St. Eustatius (van der Steen 1992:fig. 63), at the Hope Estate site on St. Martin (Jansen in press) and at pre-columbian sites on Barbados (Cartwright 1991[a]).

A total of six scrapers were found (fig. 63a, page 130). Their lengths range from 37 to 71 mm, their widths from 22 to 42 mm, and their thicknesses from 2 to 17 mm. Their weights are between 1 and 26 g. Three very thin and finely worked specimens were made out of *Cypraea zebra* shell, by cutting the shell along its length and removing the inner whorl. Their edges have been rounded, smoothed, and polished. Slight use-wear is exhibited on the edges of two of them. An other scraper has been roughly formed out of an unidentified shell species. The two other scrapers were made out of *Strombus gigas* shell. One is a thick spoon-like artefact, of which the edges have been carefully rounded and smoothed. The other one is a thin and finely worked specimen. Its edges and surfaces have been smoothed and polished. Use-wear is present on the cutting edge. At the Golden Rock site on St. Eustatius, *Cypraea zebra* scrapers were the most commonly found artefacts (van der Steen 1992:95). They have also been recorded for sites on Guadeloupe (Clerc 1974:figs. D5,D25),

and for the Hope Estate site on St. Martin (Jansen in press). Van der Steen (1992:95-96) suggests that they might have been used to scrape organic soft material.

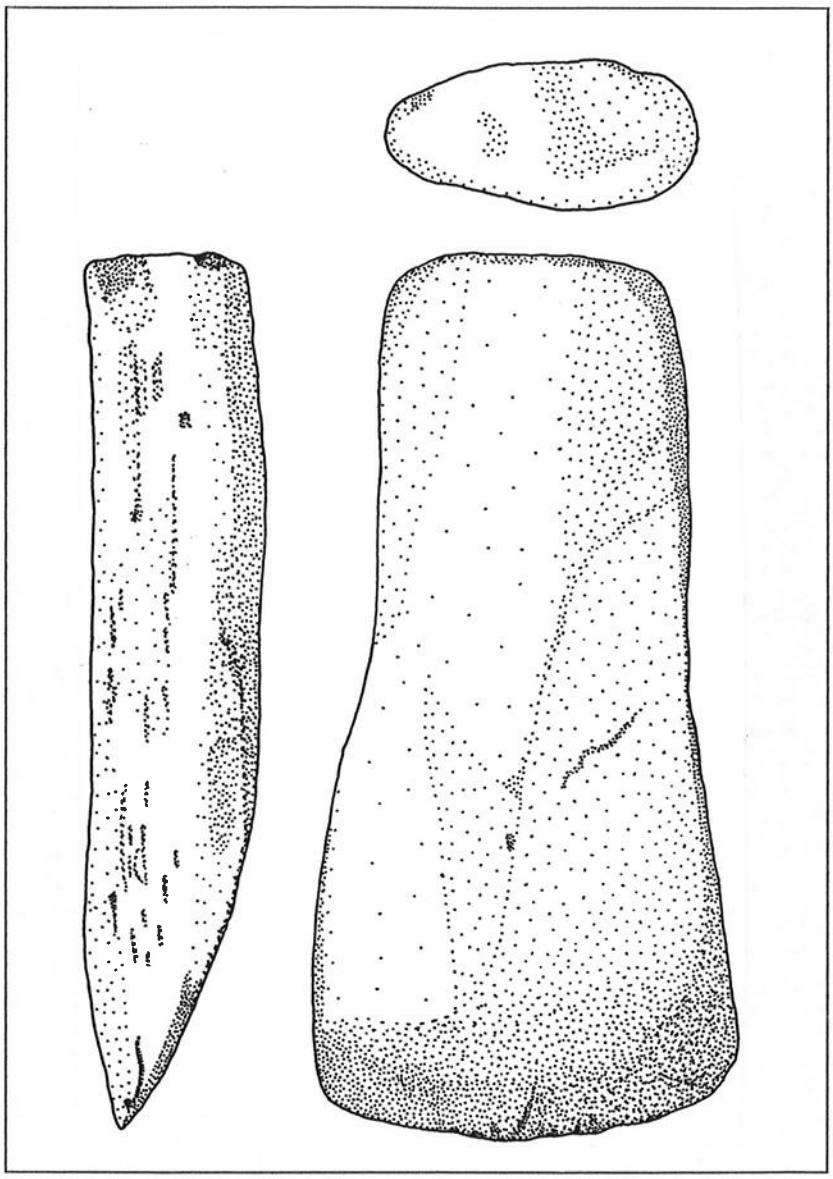


Figure 62. Petite Rivière shell artefacts: *Strombus gigas* axe (scale 1:1)

The 1984 excavations provided also a pointed tool made out of *Strombus gigas* (fig. 63b, page 130), and a hook of *Cittarium pica* (fig. 63c, page 130). The pointed tool had been carved out and polished. Its dimensions are 47x8x5 mm, and its weight is 4 g. It might have functioned as a puncturing or drilling tool. The hook had been carved out of a compact piece of *Cittarium pica*, where the bladdery structure, that is characteristic for this shell species, was absent. Its dimensions are 32x9x7 mm, and its weight is 4 g. It might have functioned as a fishing hook, or as an instrument to remove shellfish from their shells.

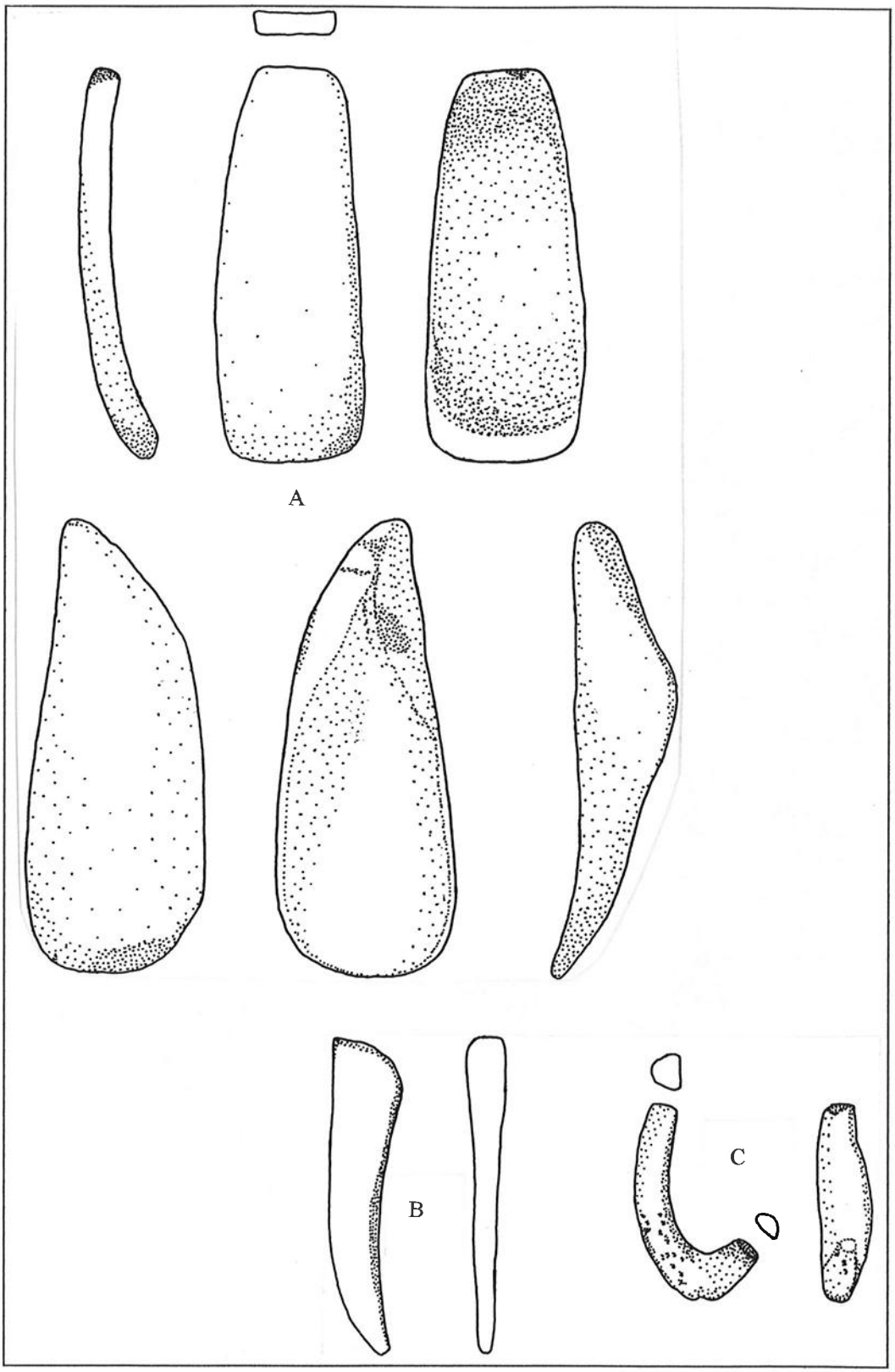


Figure 63. Petite Rivière shell artefacts: A. *Strombus gigas* scrapers; B. *Stombus gigas* pointed tool; C. *Cittarium pica* hook (scale 1:1)

Shell ornaments

The fine sieving procedures of the 1995 excavations provided four beads (fig. 64a, page 133). No pendants or tinklers were found. Beads have been defined by van der Steen (1992:96) as "discoidal or cylindrical objects with a hole in the middle and meant to be threaded on a string". A total of three thin, flat and rounded beads were found. Two of them were small, with an average diameter of 4.5 mm, an average thickness of 1.3 mm, and an average perforation diameter of 1.6 mm. The holes are perfectly round and must have been made by puncturing a preformed and smoothed shell circle with a thin and sharp tool. The other rounded bead, of which only half was found, has a diameter of 13 mm, a thickness of 4.3 mm and a perforation of 3 mm. This specimen has been decorated with incisions on the sides. Also half of a rectangular bead was found. It measures 9x7x4 mm. The hole in the middle is irregular. At one side it is 4 mm wide, and at the other side 2 mm. Probably all the beads were made out of *Strombus gigas* shell. The manufacturing of shell beads could be reconstructed at the pre-Columbian Governor's Beach Site on the island of Grand Turk, Turks and Caicos Islands. This site appears to be a short-term manufacturing centre for disc beads from *Chama sarda* and *Strombus gigas*. Similar beads were produced in an experiment. First, the shells were reduced into roundish bead blanks with a pressure flaking technique, with a *Strombus gigas* collumella. Then, the two sides of the curved valve were abraded into a flat, smooth disc in an abrasive medium, such as a slurry of sand and water, on a flat, water retentive surface. The polished disc is then perforated with pump drills or bow drills, with chert drill bits. Finally, it may be polished (Carlson 1995[a]). The presence of beads shows that shell artefacts played a role in personal decoration and ornament. Similar beads were also reported from sites on Guadeloupe (Clerc 1974:fig. D17), the Golden Rock site on St. Eustatius (van der Steen 1992:fig. 73), the Silver Sands site on Barbados (Cartwright 1991[a]:116) and from the Hope Estate site on St. Martin (Jansen in press).

During the 1984 excavations, a small zemi was found, that had been carved out of *Strombus gigas* shell (fig. 64b, page 133). Its dimensions are 30x22x15 mm and its weight is 10 g. It had been polished, especially at the edges. No carvings were made on the surfaces of the zemi. It has a slightly concave base.

Unknown shell objects

A total of 13 shell artefacts with an unknown function were found. Among them was a complete *Cypraea cinera* shell, with a small incision. Similar objects, but with their complete tops removed, have been reported for sites on Guadeloupe (Clerc 1974), for Ile des Cailles on the Grenadines (Sutty 1978:fig. 4), and for the Golden Rock site on St. Eustatius (van der Steen 1992:99). Van der Steen (1992) considers them to be tinklers. Also unidentified are three knobbed objects from *Strombus gigas*. They are triangular, with rounded edges and one knob. Similar objects, but with two knobs, have been reported from the Hope Estate site on St. Martin (Jansen in press), and at Chatham midden on the Grenadines (Sutty 1978:fig. 8). Among the unidentified artefacts were also two long, small, and polished objects from *Strombus gigas*. One of them (fig. 64c, page 133) is broken. It has been shaped so that it can be hold easily in the hand.

4.4.4.4 Concluding remarks

Only a few shell artefacts were found at Petite Rivière. They include axes, scrapers, a pointed tool, a possible fish hook, beads, a zemi, and unidentified objects. Their manufacture technology can be described as accurate, with attention being paid to functional requirements and aesthetic standards. The manufacturing of the beads, for example, demonstrates that very precise and fine working techniques were employed. Although the beads are very small, they have been made symmetrically, the sides have been rounded and smoothed. One specimen had even been decorated.

Most of the shell artefacts (84.6%) were made out of *Strombus gigas* (table 31). The hardness, the homogeneity, and the beautiful appearance of this material make it suited for both the manufacture of tools and ornaments. A total of three (7.6%) scrapers, however, were made out of *Cypraea zebra*. This is a thin shell which suits scraping purposes. *Cypraea cinera* and *Cittarium pica* were represented by only one object. These species could probably easily be collected in the Petite Rivière bay, near the site. They provided all the functional and aesthetic characteristics that were required for the manufacturing of tools and ornaments.

shell species	N	%	shell species	N	%
Strombus gigas	33	84.6	*Cittarium pica*	1	2.6
Cypraea cinera	1	2.6	Unidentified	1	2.6
Cypraea zebra	3	7.6	Total	39	100.0

Table 31. Shell species used for Petite Rivière artefacts

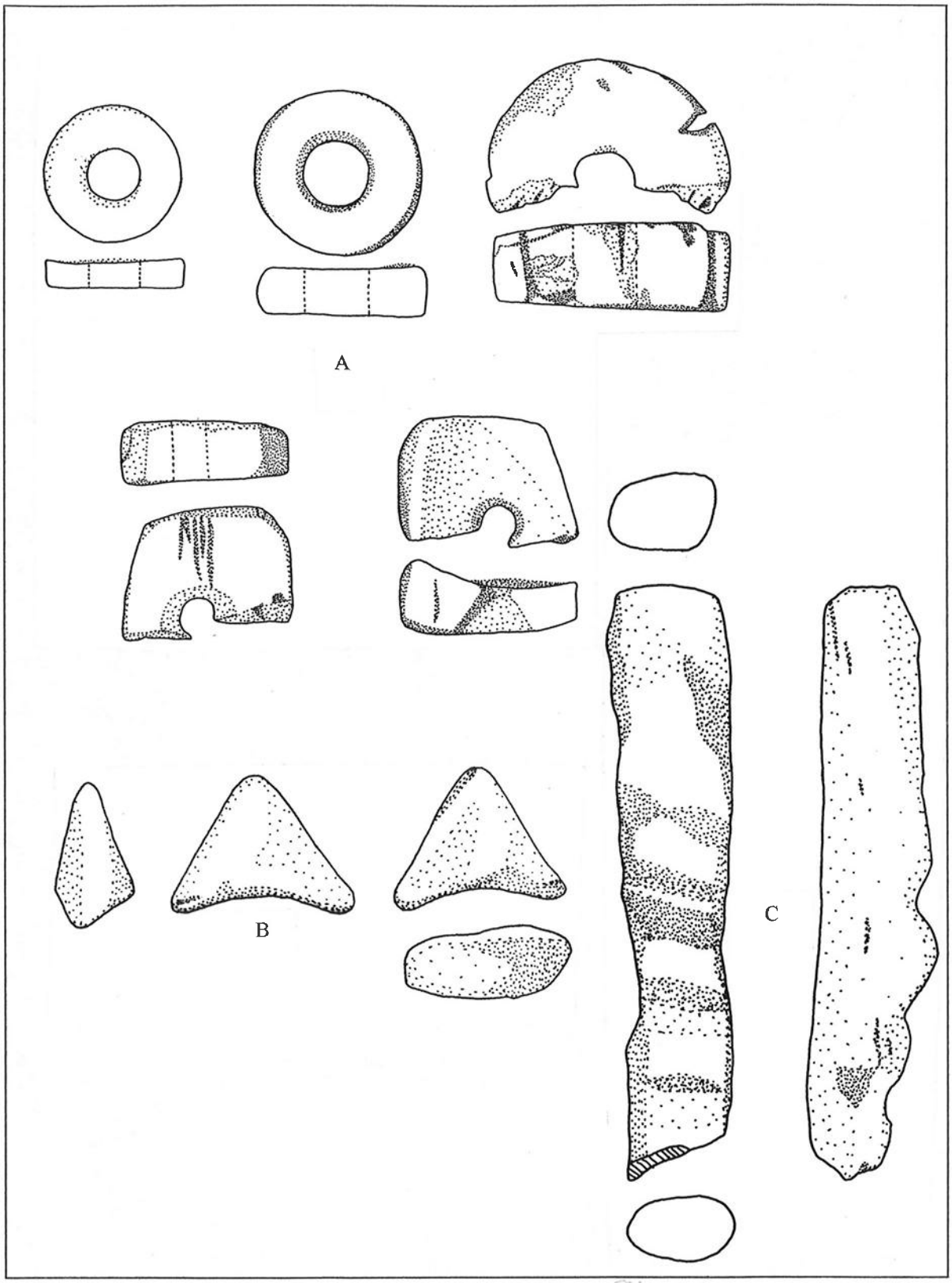


Figure 64. Petite Rivière shell artefacts: A. *Strombus gigas* beads (scale 1:3, except smallest beads scale 1:6); B. *Strombus gigas* zemi (scale 1:1); C. *Strombus gigas* unidentified artefact (scale 1:1)

4.5 CORAL FRAGMENTS AND ARTEFACTS[53]

4.5.1 Introduction

Corals consist of a wide variety of animals. They include stinging or fire corals, soft corals, and stony corals. Stony corals consist of more than 6,000 marine species which are normally attached or non-moving and which have a similar basic structure, the polyp-form. They are the main reef builders and the most familiar corals. During life stony corals are covered with a thin layer of tissue that may have any colour, but coral skeletons from archaeological context are white (Steenvoorden 1992:120-121). Coral growth is mainly restricted to sheltered cliffs and cobbly sea-floors, the leeside of boulders, and to some locations where the bedrock lacks a sandy or muddy cover (Roos 1971:14). Most Windward Islands are characterized by a similar, scattered coral growth.

Coral fragments are found in most archaeological sites, especially in coastal ones. Unfortunately, only a few reports exist on coral fragments found in excavations. Methods for cleaning and conservation of corals from archaeological contexts are described by Sipe et al. (1980). A detailed description of the corals of the Golden Rock site on St. Eustatius was made by Steenvoorden (1992). It is often difficult to determine whether fragments are from archaeological context or not, as they might have been blown to the land during storms. In some cases, however, coral fragments in archaeological context show working traces and/or use-wear. In this perspective, corals might be informative on pre-Columbian technology and on the use and/or exploitation of the environment.

4.5.2 Provenance of the coral fragments and artefacts

The analysed coral fragments were found during the 1995 fieldwork. The fragments were recovered by 2.8 mm and 2.0 mm sieving, but only those fragments left over after 5.6 mm sieving were used in the analysis. In all the units, the fragments were found uniquely in the upper layer. Of the 1995 units, units 11 and 13 appeared to have produced the largest quantity of coral in weight, respectively 20.4% and 24.5% of the total sample represented (fig. 65, table 32).

[53] Based on Roos (1971) and Steenvoorden (1992).

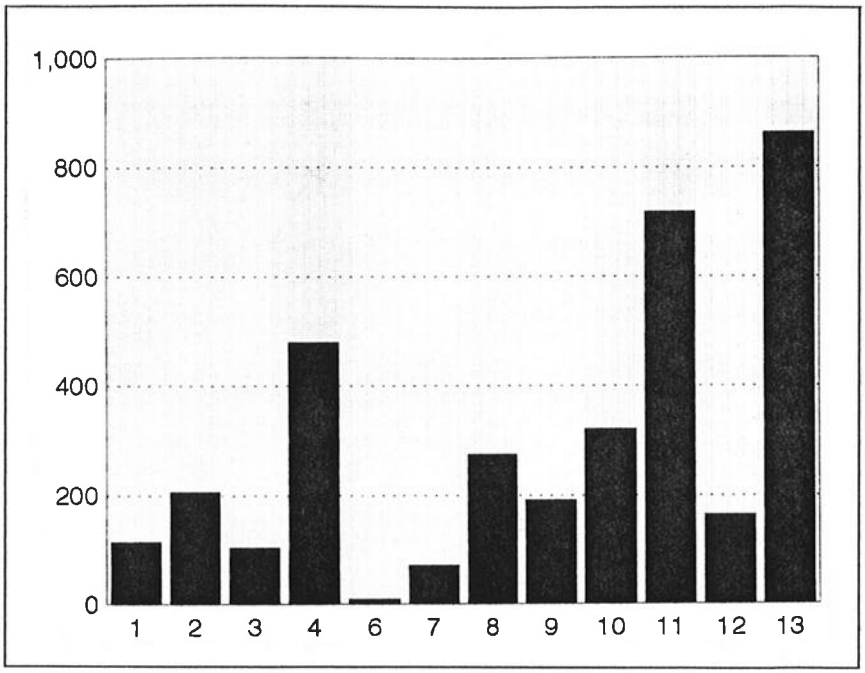


Figure 65. Petite Rivière coral per unit

unit	weight (g)	%	unit	weight (g)	%
1	115	3.3	9	191	5.4
2	207	5.9	10	320	9.1
3	105	3.0	11	719	20.4
4	480	13.6	12	165	4.7
6	10	0.3	13	863	24.5
7	72	2.0	total	3522	100.0
8	275	7.8			

Table 32. Petite Rivière coral per unit

4.5.3 Analysis of the coral fragments and artefacts

A total of 3522 g of coral was analysed. Seven stony coral species were represented (fig. 66, table 33). The predominant coral species were *Acropora palmata* (50.8%), *Siderastrea siderea* (18.3%), and *Acropora cervicornis* (14.0%). Other species, such as *Montrastrea cavernosa*, *Porites* sp., *Meandrina meandrites*, and *Colpophylla natans*, were represented by minor percentages.

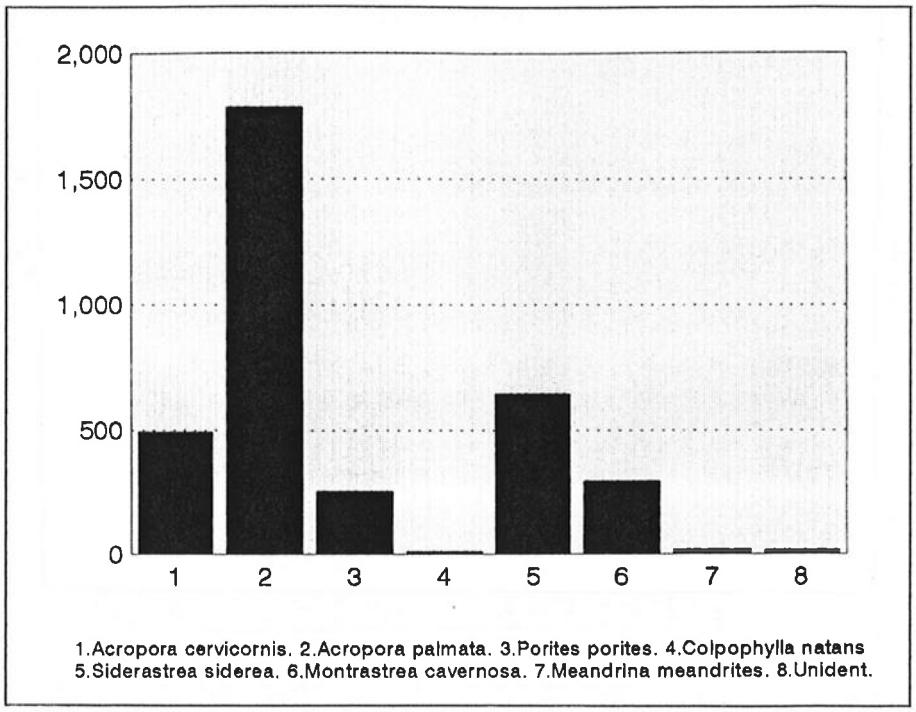


Figure 66. Petite Rivière coral species

coral species	weight (g)	%	coral species	weight (g)	%
Acropora cervicornis	493	14.0	*Montrastrea cavernosa*	295	8.3
Acropora palmata	1788	50.8	Unidentified	17	0.5
Porites sp.	255	7.2	*Meandrina meandrites*	20	0.6
Colpophylla natans	10	0.3	total	3522	100.0
Siderastrea siderea	644	18.3			

Table 33. Petite Rivière coral species

A total of 101 fragments (64.3%) are tools. They show working traces or use-wear. No decorative or non-utility objects were encountered. The artefacts will be shortly described per coral species (figs. 67-69, table 34).

4.5.3.1 Acropora cervicornis

Acropora cervicornis is a commonly occurring coral species in the Caribbean. It has small branches, that are circular in cross section, with very rough surfaces. The colour of a living colony ranges from light greyish to yellowish-brown. They occur well below the surface but not deeper than 10 m. Their natural habitat is in shallow water in quiet bays and at the lee sides of islands, where they occur on sandy bottoms. They often occur in clusters of considerable size. They are generally not found in inner bays. (Roos 1971:53-55; Steenvoorden 1992:124).

Acropora cervicornis artefacts are rather well represented with 37 specimens (36.6%). Their length ranges from 8 to 70 mm, their width from 6 to 18 mm, their thickness from 5 to 17 mm, and their weight from 1 to 60 g. The limited dimensions can be explained as a result of the high breaking rate, which is caused by the long, thin, and therefore vulnerable form of the branches.

On the basis of use-wear, all *Acropora cervicornis* artefacts are considered to have been used as rasps. This use-wear consists of a flattening and smoothing of the naturally rough surfaces of the branches. This is caused by rubbing and rasping other substances. *Acropora cervicornis* provides useful rasps by its natural shape. Steenvoorden (1992:125) suggests that their use may have been to "rasp cassava, and to file or to polish wood, shell, and bone". The Petite Rivière fragments seem to have been used predominantly for rubbing a flat surface, which resulted in a flattened side over the total length of the tool. Their use is different from, for example, the *Acropora cervicornis* fragments from the Golden Rock site on St. Eustatius, where the points of the fragments were mainly used, as is evidenced by their worn down, sharpened ends (Steenvoorden 1992:125-127). The fragments may also have been used for rubbing natural pigments. Steenvoorden (1992:127) even reports their use in the pottery manufacturing process, based on the finds of black volcanic sand, quartz, and chamotte in the pores of some of the Golden Rock artefacts. Unfortunately, no surface residues were found on the Petite Rivière specimens.

Some rough fragments also appear. According to Steenvoorden (1992:125) this suggests that they were harvested from the reef, which is their natural source. The branches might have been taken complete to the site, where they were subdivided in smaller fragments. The straight and thin fragments seem to have been selected. The useless fragments must have been discarded, although they do not occur frequently in the sample. However, the possibility should not be excluded that fragments have been used that were naturally washed to the beach. These fragments may have been rather smoothed, as a result of wave-action.

4.5.3.2 Acropora palmata

Acropora palmata occurs in encrusting or branched colonies often together with *Acropora cervicornis*. Its branches are usually thick and horizontally flattened or frondlike plates, that are sometimes turbinate. This coral is very common in the Caribbean, as it is thought to be the most adaptive to prevailing water-movements. In very shallow water or in heavy surf it may be encrusting, and in calm water it spreads its thick, flattened branches into all directions. It does not occur in inner bays. This coral species is easy to be collected from its natural habitat. Its hardness and rough surface, which is comparable to the surface of *Acropora cervicornis*, make it well suited for use as a grinder (Roos 1971:55-56; Steenvoorden 1992:121-122).

With 52 artefacts (51.5%), *Acropora palmata* is the predominant coral species at the Petite Rivière site. The dimensions of the worked or used fragments range from 13 to 84 mm length, 10 to 90 mm width, 8 to 45 mm thick, and the weight ranges from 2 to 200 g. Many fragments are small, which suggests that many of the artefacts had been broken. The 52 *Acropora palmata* artefacts had been used as grinders. This is demonstrated by the use-wear on the specimens, that consists of flattened and smoothed parts on the branches. In most cases the fragments were too small to distinguish the sort of grinder represented. A total of three fragments are thought to represent metates, and three others are thought to have served as manos. It was possible for only eight *Acropora palmata* specimens to study the way they had been worked, due to the fragmentation of the material. First, the rough form of the artefact had been cut, and afterwards the sharp and rough edges were rounded and smoothed. The *Acropora palmata* artefacts may have been used in the grinding of, for example fibres, vegetal foods, and natural pigments, although no residues were found on the surfaces.

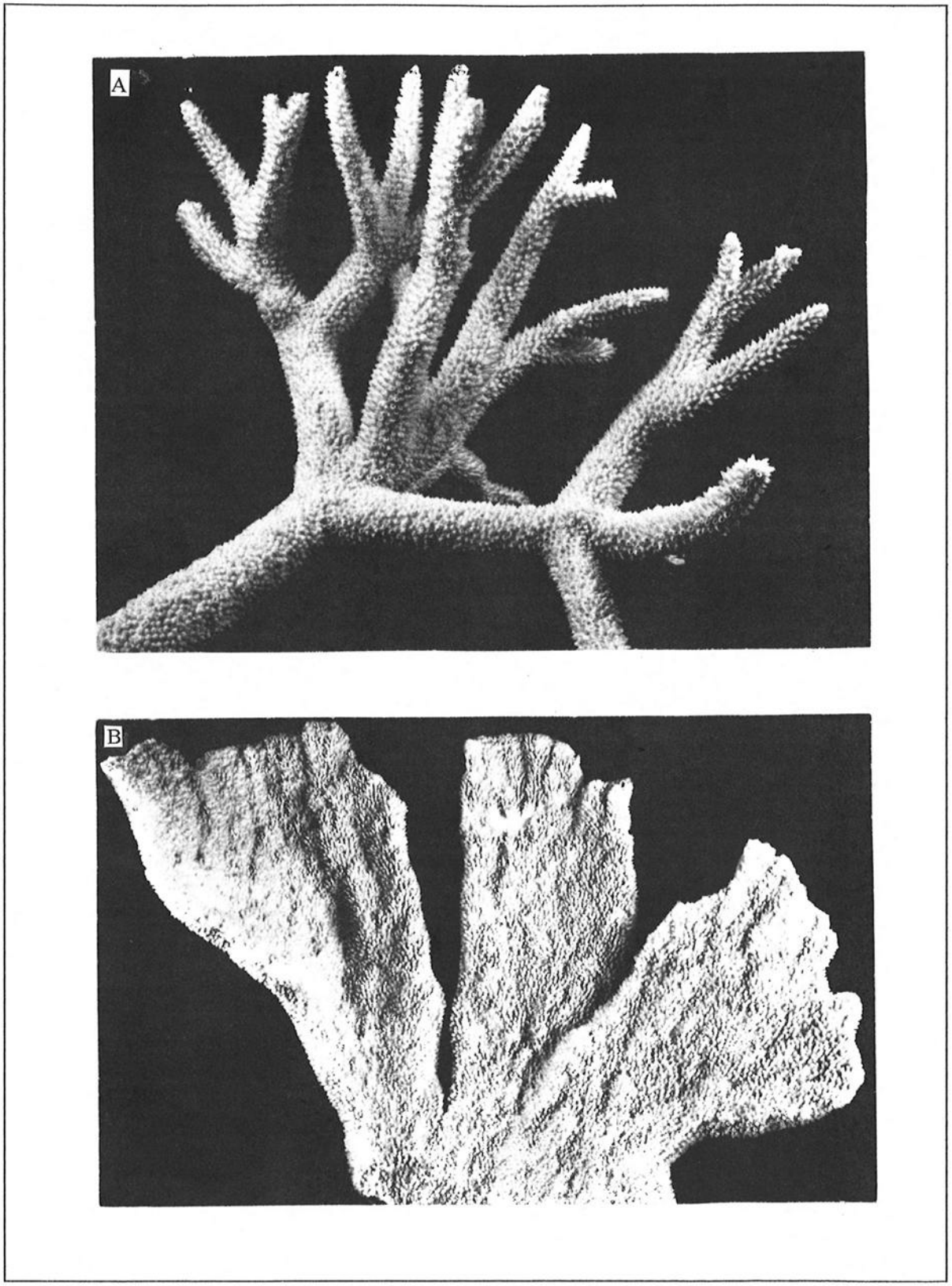


Figure 67. Petite Rivière corals: A. *Acropora cervicornis*; B. *Acropora palmata* (After Roos 1971)

4.5.3.3 Porites species

Porites corals grow in massive, encrusting, or branching shapes (Steenvoorden 1992:128), and they are common at depths less than 25 m. Most living *Porites* colonies are white or grey (Roos 1971:59-60).

Only five (5.0%) *Porites* artefacts were found. They probably belong to the *Porites porites* species. *Porites* corals have a fine and soft texture. Therefore, they are easy to work, and they can be used for fine grinding or polishing activities. They show more use-wear than other coral species. As a result of soft grinding or polishing activities, e.g. on wood, bone or shell as proposed by Steenvoorden (1992:129), polished edges are created. A total of three specimens can be interpreted as soft grinding or polishing tools, on the basis of this use-wear. The function and use of the remaining two specimens remains unknown, as their dimensions are too limited. The worked or used fragments are between 18 to 88 mm long, 14 to 65 mm width, 10 to 25 mm thick, and their weights range from 3 to 110 g. The *Porites* artefacts were probably only roughly shaped.

4.5.3.4 Siderastrea siderea

Sidersastrea siderea occurs in inner bays and the open sea, but not on muddy bottoms, nor near the water surface. It is common at approximately 10 m. In shallow waters the coral may be encrusting, but more often hemispherical masses are encountered. The colour of the living colony is mostly light reddish brown (Roos 1971:63-64). The fine structure of this species allows soft grinding or polishing functions.

A total of six (5.9%) *Siderastrea siderea* artefacts were found. Five of them are thought to have been used as a grinder, on the basis of their use-wear. One other specimen is too fragmented to study its use and function. The lengths of the used fragments range from 15 to 85 mm, the widths from 13 to 55 mm, their thicknesses from 5 to 38 mm, and their weights from 3 to 103 g.

4.5.3.5 Meandrina meandrites

Meandrina meandrites occurs at the lee sides of islands. It does not occur in land-locked bays, and it is not found deeper than 25 m. Meandroid colonies are mostly spherical or hemispherical. The colours of the living colonies vary from yellow to brown, while white tentacles expand at night (Roos 1971:76).

Only one (1.0%) worked or used fragment of *Meandrina meandrites* was encountered. It was probably used as a grinder. Its dimensions are 31x28x20 mm. Its weight is 20 g.

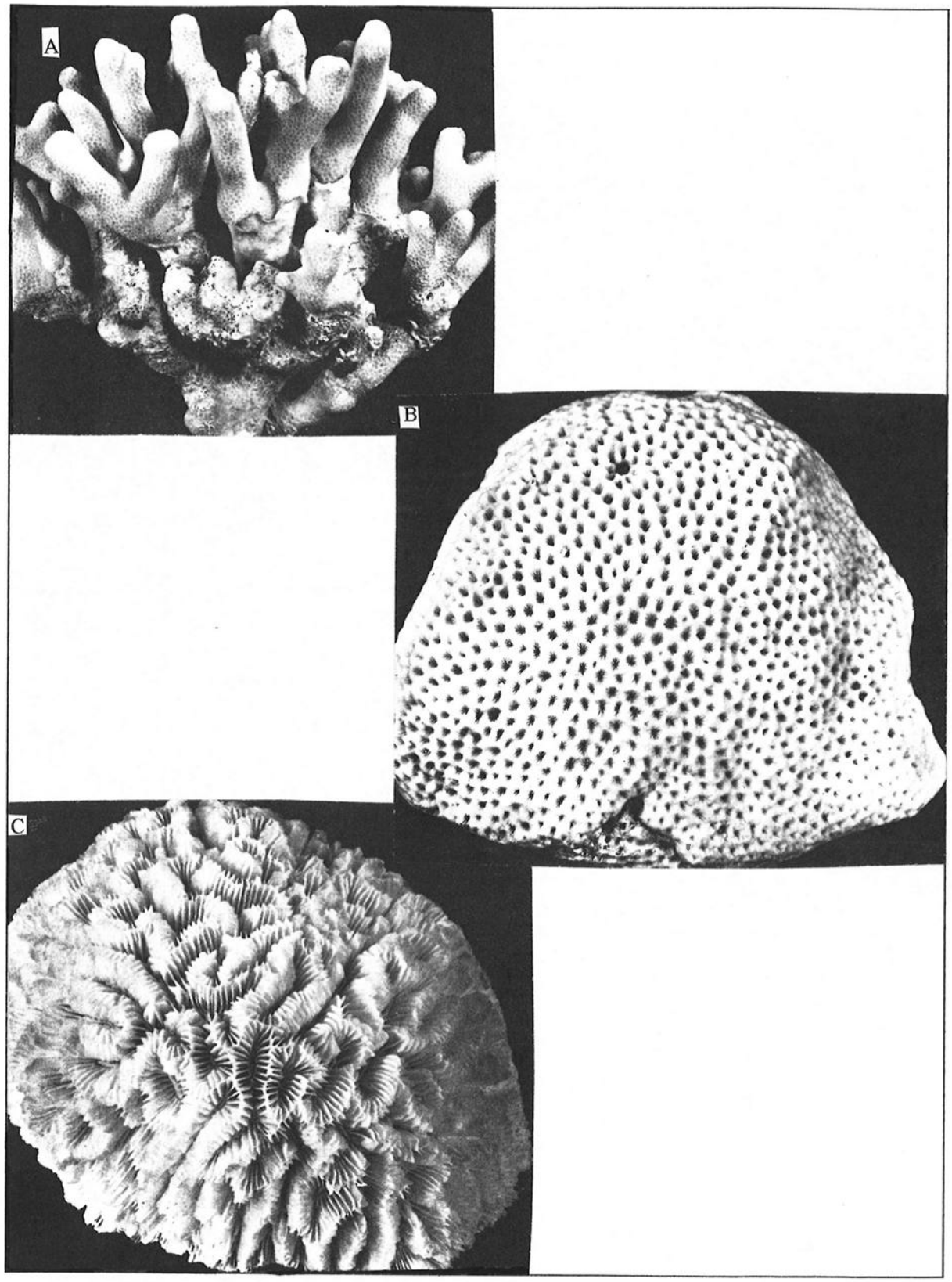


Figure 68. Petite Rivière corals: A. *Porites porites*; B. *Siderastrea siderea*; C. *Meandrina Meandrites* (After Roos 1971)

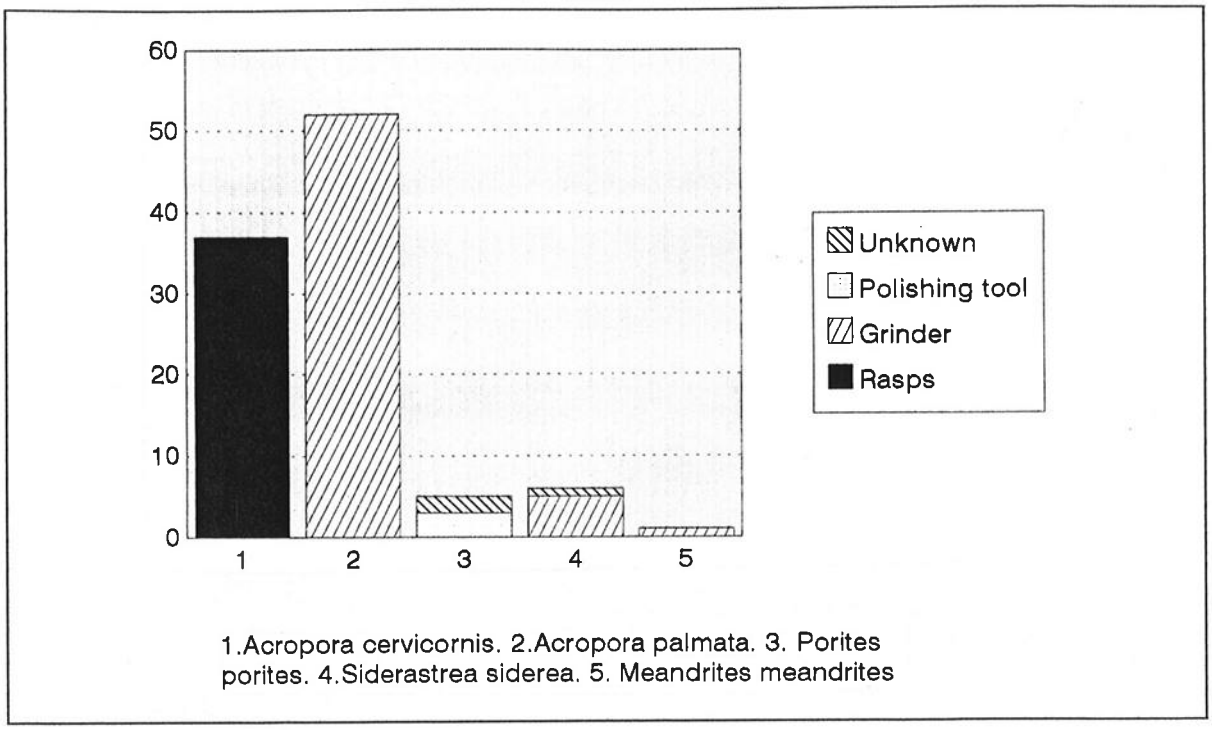


Figure 69. Petite Rivière artefact types per coral species

coral species	N	%	Rasp N	Grinder N	Pol.tool N	Unknown N
Acropora cervicornis	37	36.6	37			
Acropora palmata	52	51.5		52		
Porites sp.	5	5.0			3	2
Siderastrea siderea	6	5.9		5		1
Meandrina meandrites	1	1.0		1		
total	101	100.0	37	58	3	3

Table 34. Petite Rivière coral species and their artefacts

4.5.4 Concluding remarks

Regarding the species represented by a site's coral artefacts, it should be possible, not regarding the limited size of the sample, to identify what zones around the island were exploited, and whether there was an emphasis on specific zones or on specific coral species. It must be supposed then that natural conditions allow the same circumstances as in pre-Columbian times, and that the coral species used originate from the immediate environs of the island.

The emphasis in the use of corals was probably on *Acropora palmata* (51.5%), and *Acropora cervicornis* (36.6%). The other species, *Porites* sp., *Siderastrea siderea*, and *Meandrina meandrites* are represented by minor percentages. *Acropora palmata* and *Acropora cervicornis* may be considered to be the dominant corals in almost all reefs (Milliman 1973:14-15). For most pre-Columbian sites in the Caribbean, *Acropora cervicornis*, *Acropora palmata*, and *Porites* sp. are the most common species reported (Steenvoorden 1992:137). The species found at Petite Rivière are widely occurring throughout the Caribbean. The natural conditions in which they flourish have some similarities. In general, corals are greatly influenced by light. Therefore, corals are often restricted to clear waters and to the uppermost parts of the seas and oceans (Roos 1971:93). The Petite Rivière corals are all occurring in shallow waters. The waters near the coastline at the lee side of La Désirade are not very deep. Thus, coral growth will not be limited because of the light. Water movements also effect coral growth (Roos 1971:95). Only *Acropora palmata* resists strong water movements. At the north coast of the island, extensive coral growth can hardly be expected. The lee side of the island is protected from strong water movements by extended reefs, where corals flourish. Those reefs protect the bay of Grande Anse, and the complete south coast extending from Le Désert, via Le Souffleur, towards Anse Petite Rivière. Anse Petite Rivière itself is one of the most protected and shallow bays on the island. The corals found at the site may have their origins here. *Acropora cervicornis*, *Meandrina meandrites*, and *Porites* sp. might occur on the bay side of the reef, where sandy bottoms can be found. *Sidersastrea siderea* might occur on both sides of the reef as long as it is not on muddy bottoms, nor near the water surface. *Acropora palmata* might be also found on both sides of the reef, as long as the water is less than 1 m deep. For this species however, it is to be expected that the bay side of the reef has been exploited more easily then the ocean side of the reef.

Thus, the pre-Columbian inhabitants of the Petite Rivière site seem to have focused on the exploitation and use of corals that could easily be used as tools, as a result of their physical characteristics and which could easily be acquired as a result of their accessible habitats near the site.

4.6 FAUNAL REMAINS[54]

4.6.1 Introduction

The excavations of the Petite Rivière site provided several vertebrate and invertebrate faunal remains. A sample of this material was selected and subjected to zooarchaeological analyses. This sample was sent to Cayenne (French Guyana) where it was studied by S. Grouard[55]. In the present study, a provisional report on these faunal remains is presented. A more detailed study of the Petite Rivière faunal remains will be published in a Ph.D thesis at the University of Paris 1 (Grouard in press). It will be tried to get an idea of what animals occurred in the food economy, of what habitats were exploited, and if hunting specialisation could be distinguished.

4.6.2 Provenance of the faunal remains

The 1995 Petite Rivière units provided a total of 1217 g faunal remains (table 35). The largest quantities were found in units 4 (18.5%), 12 (19.4%), and 13 (18.3%). Smaller, but still significant quantities were found in units 3 (8.0%), 10 (10.3%), and 11 (11.9%). The remaining units were represented by minor percentages. It is remarkable that faunal remains were also found in levels 2 and 3, especially in unit 4 where level 2 contained 17.3% of the faunal remains. This was not the case for the other material categories. This may be explained as a result of post-depositional processes. Due to their limited size and weight, faunal remains are easily transported through different levels by movements of animals, water or by trampling.

The 1995 units were wet-sieved over 2.8 mm mesh sieves, except for unit 4 that was wet-sieved over 2.0 mm mesh sieves. Afterwards, they were sieved over 5.6 mm sieves and sorted out in the laboratories of Leiden University. A sample was chosen, including the faunal remains from the 2.0 mm sieve residue of unit 4 and from the 5.6 mm sieve residue of unit 12.

54 Petite Rivière shell and coral remains were described in the previous paragraphs.
55 Direction Régionale des Affaires Culturelles, Cayenne (French Guyana).

unit	level	wght (g)	%	unit	level	wght (g)	%
1	1	45	3.7	8	1	11	0.9
2	1	34	2.8	8	2	<1	<0.1
2	2	6	0.4	9	1	51	4.2
3	1	87	7.1	9	2	<1	0.1
3	2	8	0.8	10	1	116	9.5
3	3	<1	<0.1	10	2	10	0.8
4	1	6	0.4	11	1	125	10.2
4	2	213	17.3	11	2	21	1.7
4	3	10	0.8	12	1	235	19.3
6	1	10	0.8	12	2	<1	<0.1
6	3	<1	0.1	13	1	228	18.3
7	3	6	0.5	total		1217	100.0

Table 35. Petite Rivière faunal remains from the 1995 units

4.6.3 Analysis of the faunal remains

Unfortunately, only a part of the results of the analyses was sent in time to the Netherlands to be included in this study. Moreover, no MNI counts could be attained as the information concerning the species represented in the sample was not detailed enough. Probably, the dimensions of the 1995 units were also too limited for reasonable MNI counts. The fauna represented in the sample could only be deduced to the level of the family (Grouard personal communication 1996). Therefore, only a superficial image can be presented here on the faunal families that are represented in the part of the sample analysed. The results of the analyses are represented in table 36[56]. The numbers of fragments per family have been used as the only possibility to come to a simplified frequency distribution as no MNI's were counted and weights were not obtained for all the families represented. Unfortunately, the number of fragments per family is not very informative because of differential preservation. Bones of large animals survive better than those of small ones, some animals have more teeth and bones than others, and the degree of fragmentation varies with the species (Renfrew and Bahn 1991:250). On the basis of these very limited results it will be tried to come to some general insights in the faunal assemblage represented at the Petite Rivière site.

[56] A more detailed table is presented in appendix 2.

The vertebrate remains of the Petite Rivière faunal assemblage include mammals, birds, reptiles, and fish[57]. A total of 3.0% of the fragments could be assigned to mammals. Among these, only rodents could be identified, e.g *Oryzomyini* sp. or rice rat (1.2%). A total of 1.4% of rodent fragments could not be identified and 0.4% belonged to unidentified mammals.

Birds might have been exploited for their feathers rather than their meat, depending of the species involved. They might also have been brought to the site by animal predators or they might have inhabited the site and its environs (Renfrew and Bahn 1991:258). Finds of bird remains are relatively scarce in prehistoric sites (Wing and Reitz 1982:20). At the Petite Rivière site, birds were only represented by 2.1% of the total sample. The main part of these could not be identified. A very small group could be assigned to Passeriformes. This is a very large family, of which 75% of the species can not be identified. A minor percentage belonged to Columbidae. This is the family of pigeons and doves. Their species could not be further identified.

Reptiles were represented by 1.4% of the sample. The main part of these belonged to Cheloniidae, which are sea turtles, and Polychridae, which are lizards. For these families, the species could not be identified in more detail. Sea turtles are present at almost every archaeological site (Wing and Reitz 1982:20). They can be caught from march until july when the females lay their eggs on beaches at night. *Iguana iguana* is only represented by 0.2% of the total sample.

The main part of the faunal remains consists of fish (81.2%)[58], most of which could not be identified (28.5%). The identified fish are predominantly perch-like (40.9%), including several families that can not further be identified. Other fish are Carcharhinidae (sharks), Myliobatidae (rays), Holocentridae, Serranidae, Lutjanidae, Haemulidae, Sparidae, Scaridae, Albulidae, Sphyraenidae, Acanthuridae, Balistidae, and Scombridae. These occur in minor percentages.

— Albulidae (*Albula vulpes*), or bonefish, occur on sand or mud flats in shallow bays, lagoons and mangroves. When they are not feeding they may be observed on coral rubble flats between shallow patch reefs or in passes between fringe reefs.
— Holocentridae (*Holocentrus* sp.), or squirrelfish, are nocturnal coral reef fish with moderate sizes and with pre-dominantly red colours. They feed on invertebrates.
— The family of Serranidae (groupers) is important and diverse. The sizes of these species vary considerably. They are solitary carnivores that live in coral reefs.
— Lutjanidae (*Lutjanus* sp.), or snappers, are fish with a moderate size. They live near coasts and reefs but many of them can be found at considerable depths, ranging between 90 and 360 m.
— Snappers are nocturnal predators that feed on crustaceans and small fish. Some of its sorts tend to be solitary, others often congregate.

---

57 It may be remarked that some of the bone fragments were burnt (table 36). This was mainly the case for fish. No burnt fragments belonging to invertebrates were found.

58 The weights of fishes have not been calculated.

— Haemulidae (grunts) are fish with a moderate size. Young individuals are often found on marine bottoms, where they eat plankton. Most individuals gather during the day near shelters. At night, they disperse in order to feed at extended sandy bottoms or bottoms covered with seaweed. They congregate during the day in the shadows of reefs. At night, the nocturnal feeders scavenge the sand flats and grass beds near reefs for crustaceans.
— Sparidae (porgies) are large fish species, most of which occur in tempered zones. They are carnivores that eat invertebrates. Porgies are solitary, and they occur close to bottoms where they feed on shellfish and crabs.
— Scaridae (parrotfish) are fish with moderate lengths. They are herbivores that eat algae on rocks and dead corals. Some species also eat living corals. They are dominant on reefs.
— Sphyraenidae (barracudas) are silvery fish that voraciously predate small fish. During the day they live in groups. They are to be found in shallow waters. They occur in various habitats.
— Acanthuridae (surgeon-fish) are reef inhabitants that often move in loose aggregations, feeding on algae.
— Scombridae (tuna and mackerel) are fish with a moderate length. They are the main deep-sea predators. They travel solitary or in groups. They are predominantly open-water fish, but sometimes they do occur near reefs.
— Balistidae (trigger fish) are solitary fish frequenting the reefs. They feed on a great variety of invertebrates. However, some among them eat algae or zooplankton (Humann 1994; Lieske and Myers 1995).

Invertebrates are represented by 11.9% of the sample. These include different crab species, such as 1.4% of *Coenobita clypeatus* (hermit crab), 2.1% of *Calinestes* sp. (sea crab), and 0.7% of land crab. Hermit crabs may be intrusive in the remains. They may have been attracted to the midden to feed and to get shells to live in. They may also have been used as bait as is done nowadays (Nokkert 1995:53). However, the main part (6.2%) of the crab remains could not be identified. The remainder of the identifiable invertebrate remains consists of Echinoid (sea-urchin) fragments (1.5%). Sea-urchins may be underrepresented as a result of their very fragile exo-skeletons (Nokkert 1995).

VERTEBRATES taxon		N fragments	% fragments	N burnt
Unident.	Unident.	15	0.4	
MAMMALS				
Rodents	Oryzomyini sp.	48	1.2	3
Rodents	Unident.	57	1.4	10
Unident.	Unident.	14	0.4	
Total mammal		119	3.0	13
BIRDS				
Aves	Unident.	73	1.8	1
Aves	Passeriforme	7	0.2	
Columbidae	Unident.	1	<0.1	
Total bird		81	2.1	1
REPTILES				
Chelonidae	Unident.	27	0.7	3
Polychridae	Unident.	22	0.5	
Iguanidae	Iguana iguana	8	0.2	
Total reptile		57	1.4	3
FISH				
Unident.	Unident.	1154	28.5	56
Carcharhinidae		1	<0.1	
Mylobatidae	Aetobatis narinari	4	0.1	
Holocentridae	Holocentrus sp.	169	4.2	15
Perch-like		1657	40.9	134
Serranidae		23	0.6	
Lutjanidae	Lutjanus sp.	13	0.3	2
Haemulidae		28	0.7	
Sparidae		69	1.7	
Scaridae		61	1.4	
Albulidae	Albula vulpes	3	0.1	
Sphyraenidae		2	0.1	1
Acanthuridae		32	0.8	
Balistidae		61	1.4	6
Scombridae		13	0.3	
Total fish		3290	81.2	214
INVERTEBRATES				
Crab	Unident.	249	6.2	
Crab	Coenobita clypeatus	56	1.4	
Crab	Calinectes sp.	84	2.1	
Crab	Land crab	29	0.7	
Echinoid	Unident.	64	1.5	
Total Invertebrate		482	11.9	
Total		4044	100.0	231

Table 36. Petite Rivière faunal fragments per family (After Grouard personal communication 1996)

The Petite Rivière faunal assemblage can be confined to the following habitats[59] (fig 70, page 150; table 37, page 151). It must be remarked that an important part of the sample (37.3%) could not be assigned to a specific habitat as several bone fragments could not be identified. Only 5.7% of the faunal remains belongs to terrestrial species. Mammals, such as Oryzomyini and other rodents make up 2.6%. Reptiles and birds account for less than 1%. Terrestrial invertebrates, such as *Coenobita clypeatus* and land crab, make up 2.1% of the sample. The habitat of beach-turtle grass, is only represented by Chelonidae (0.7%). The most important habitat represented among the Petite Rivière faunal remains is the aquatic habitat (56.3%). Most of this fauna, such as Carcharhinidae, Mylobatidae, and perch-like species (41.1%) and marine invertebrates (3.6%), can be found in various aquatic environs. An other habitat is represented by the inshore-estuarine habitat. This habitat is enriched by a run-off of water and nutrients from the land. It is consequently subject to fluctuating salinities. The substrate is typically a sand, mud, or grassy bottom. In the Petite Rivière sample only Sparidae (1.7%) could be assigned to this habitat. Better represented is the coral reef habitat (9.5%). Most of the fish in this group belong to the Holocentridae (4.2%). Scaridae, Acanthuridae, Albulidae, Serranidae, Lutjanidae, Haemulidae, and Balistidae are represented by minor percentages. The last habitat is the offshore-pelagic habitat. Only 0.4% of the total sample could be assigned to this habitat. Scombridae and Sphyraenidae were found here.

The fish species that occur in the Petite Rivière sample might also provide information on fishing techniques. Fishing techniques used in pre-Columbian times are known from the few implements that have been recovered by archaeologists, early historic descriptions, ethnological studies, and from study of archaeological fish remains (Wing and Reitz 1982:24). Basic fishing equipment includes hooks, gorges, spears, nets, traps, and poison[60]. The usefulness of these tools depends on different behavioural or morphological characteristics of fish. For example, not all fish types are able and willing to take a hook. Spears are useful where fish or other large aquatic animals are concentrated in shallow clear water. Nets may be effective in calm areas with smooth bottoms, e.g in the inshore-estuarine habitat. Trapping is the method most frequently used today to catch reef fish. Archaeologically, this method can be demonstrated by a great uniformity in size of fish fauna of sites (Wing and Reitz 1982:24-26). Most of the Petite Rivière species are common in various aquatic habitats, and over coral reefs and rocky banks. The reef habitat is represented by 9.5% of the total sample. Scaridae (parrotfish), Acanthuridae (surgeonfish), Holocentridae (squirrelfish), Albulidae (bonefish), Serranidae (groupers), Lutjanidae (snappers), Haemulidae (grunts), and Balistidae (trigger fish) are encountered here. They may be caught with traps, nets or lines depending whether the bottom is rocky or sandy. Nets may have been impractical, because they can

59 After Wing and Reitz (1982).

60 Fish poisons have limited use in marine situations.

not easily be moved over reefs (Nokkert 1995). Herbivorous reef species, such as parrotfish and surgeonfish, are typically caught in traps nowadays as they will not take a hook. Groupers, snappers and grunts can be caught in traps but they can also be taken with hook and line. Schools of parrotfish, surgeonfish, snappers, and grunts can be caught in traps set along their migration routes.

Only 0.4% of the faunal remains represent species that are common in the off-shore pelagic habitat. Among these are Scombridae (tuna and mackerel) and Sphyraenidae (barracuda). Deep sea fish may be caught with hook and line, or by dragnet fishing. The evidence for pelagic fishing is so limited, however, that it is thought that the fragments that do occur in the sample probably belonged to fish that got lost near coral reefs and that were caught together with reef fish (Grouard personal communication 1996). Barracudas can sometimes be found over reefs and in inshore waters.

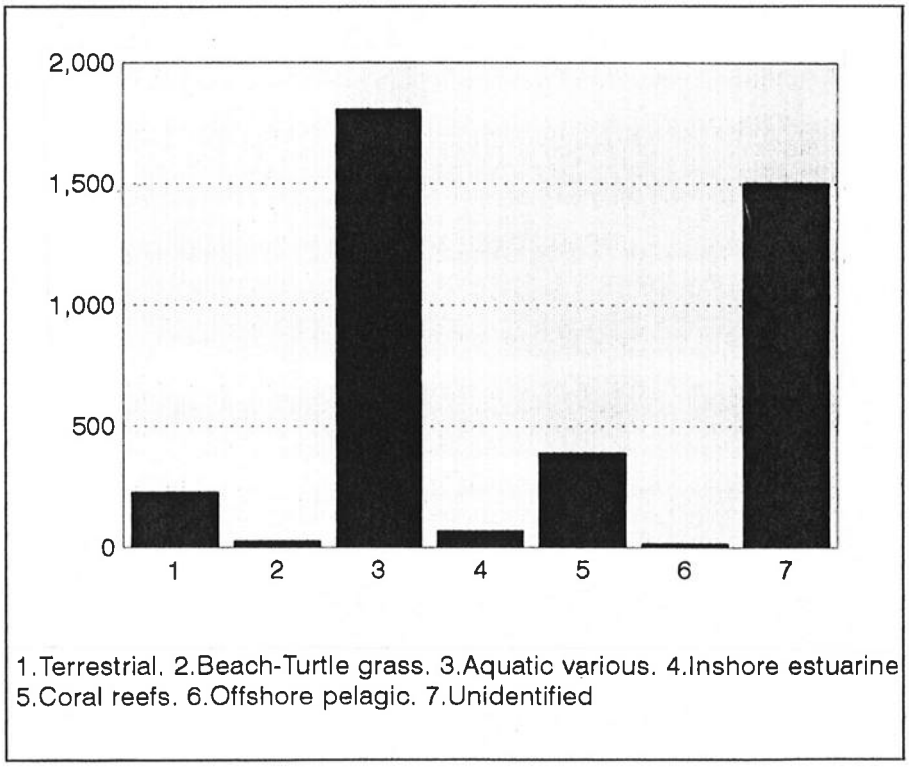


Figure 70. Petite Rivière faunal fragments per habitat

Habitat	Taxon	N fragments	% fragments
TERRESTRIAL	*Oryzomyini* sp.	48	1.2
	Unident. rodents	57	1.4
	Passiforme	7	0.2
	Columbidae	1	<0.1
	Iguana iguana	8	0.2
	Polychridae	22	0.5
	Coenobita clypeatus	56	1.4
	Land crab	29	0.7
BEACH-TURTLE GRASS	Chelonidae	27	0.7
AQUATIC Various	*Calinestes* sp.	84	2.1
	Carcharhinidae	1	<0.1
	Mylobatidae	4	0.1
	Perch-like	1657	40.9
	Echinoid	64	1.5
AQUATIC Inshore-estuarine	Sparidae	69	1.7
AQUATIC Coral reefs	Scaridae	61	1.4
	Acanthuridae	32	0.8
	Holocentridae	169	4.2
	Albulidae	3	0.1
	Serranidae	23	0.6
	Lutjanidae	13	0.3
	Haemulidae	28	0.7
	Balistidae	61	1.4
AQUATIC Offshore-pelagic	Scombridae	13	0.3
	Sphyraenidae	2	0.1
Unidentified	Unidentified	1505	37.3
Total		4044	100.0

Table 37. Petite Rivière faunal fragments per habitat (After Nokkert 1995)

4.6.4 Conclusions

The main part of the Petite Rivière faunal remains consists of fish and most of them are perch-like. Other species represented include *Oryzomyini* sp. (rice rat), unidentified rodents, Passeriformes, Columbidae, Cheloniidae, Polychridae, *Iguana iguana*, Carcharhinidae, Myliobatidae (*Aetobatis* sp.), Holocentridae (*Holocentrus* sp.), Serranidae, Lutjanidae (*Lutjanus* sp.), Haemulidae, Sparidae, Scaridae, Albulidae, Sphyraenidae, Acanthuridae, Balistidae, and Scombridae, *Coenobita clypeatus*, *Calinestes* sp., land crab, and Echinoid.

These species can be assigned to different habitats, the terrestrial habitat (5.7%), the beach-turtle grass habitat (0.7%), and the aquatic habitat (56.3%). The aquatic habitat may be subdivided in different zones, such as the category of various aquatic zones (44.7%), the inshore-estuarine habitat (1.7%), the coral reef habitat (9.5%), and the offshore-pelagic habitat (0.4%). The composition of the prehistoric fauna might be considered as a guide to the choices made by the inhabitants of the site (Wing and Scudder 1980). The Petite Rivière sample, however, is to limited to reconstruct hunting specialisations. Some information, however, might be provided on fishing techniques. Fish that occurs in the most commonly used habitats are Scaridae (parrotfish), Acanthuridae (surgeonfish), Holocentridae (squirrelfish), Albulidae (bonefish), Serranidae (groupers), Lutjanidae (snappers), Haemulidae (grunts), and Balistidae (trigger fish). They may have been caught in traps. The few pelagic fish that do occur in the sample have been explained as accidental catches together with reef fish.

It may be concluded that the pre-Columbian inhabitants of the Petite Rivière site mainly made use of marine foods. Most of these fish was caught on reefs, e.g on the reef which is in the Petite Rivière bay, near to the coast. A similar picture was found for pre-Columbian Barbados. Few land mammals were present, so most protein was derived from marine resources with both inshore and deep-water fishing supplementing the extensive use of shellfish. Only the rice rat seemed to have been present. Prehistoric humans introduced the small indian dog. Marine resources were, however, considerable and varied. There is clear evidence for fishing, collecting shellfish, catching turtles and eating sea urchins and crabs (Drewett 1989:79-90).

4.7 HUMAN SKELETAL REMAINS

4.7.1 Provenance of the human skeletal remains[61]

During the 1984 excavation campaign, two Amerindian human burials were found near the midden remains at the eastern part of the site (fig. 71). The first individual had been buried near the surface in a fetal position. The cranium had been covered by a ceramic bowl. The second burial was situated under the first individual. It had been buried on the back in a completely stretched position, while the limbs had been positioned along the thorax (Bodu personal communication 1996).

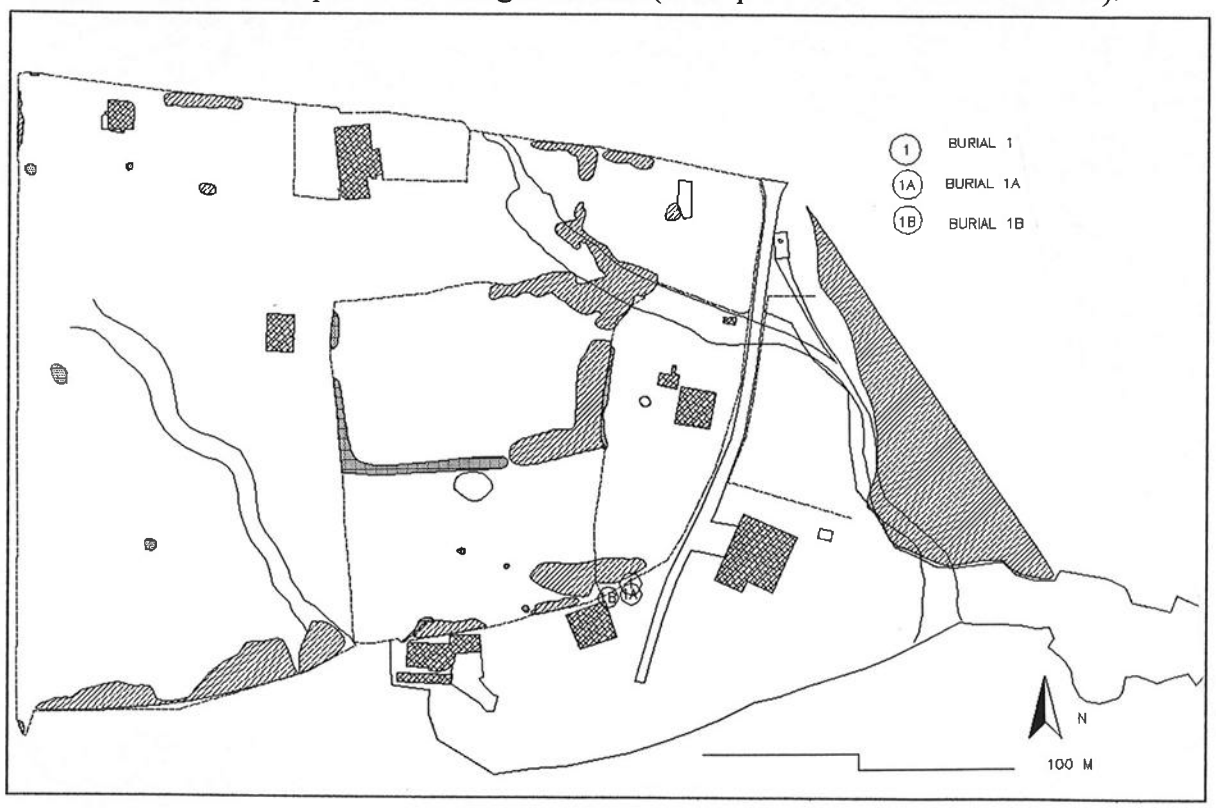


Figure 71. Location of the Petite Rivière burials

A third human skeleton from the Petite Rivière site was discovered in the depot of the Edgar Clerc museum in 1994. It had probably been excavated prior to the 1984 campaign. It was probably situated west of the 1984 burials (fig. 71), where H. Petit-jean Roget noticed a dark spot in the bulldozered profile in 1983, which he interpreted as a burial. Unfortunately, no information is available on the excavation and the burial position of this individual. The possibility can not be

61 The 1995 excavations did not provide human skeletal remains.

excluded that it was buried together with the first skeleton, which appeared to be rather disturbed (Bodu personal communication 1996).

The three Petite Rivière burials had been deposited in the depot of the Edgar Clerc museum. Unfortunately, several bones that belonged to different individuals had been bagged together, and their conservation is bad. Therefore, possibilities for their analysis were limited. Thus, the objectives of this study were to obtain as much information as possible on the individuals, and to study the possible dietary information provided by physical examination of the individuals.

4.7.2 The analysis of the burials

For the analysis of the human skeletal remains, a detailed 'Physical Anthropological Report' was used. This report was designed in 1995 by prof. dr. G.J.R. Maat for the Centre for Physical Anthropological Research in Leiden (The Netherlands). This report uses the methods as stipulated by the "Workshop of European Anthropologists" (1980). Non-metrical sex and age features were scored with the use of standards given by Acsádi and Nemeskéri (1970), and dental attrition and pathological changes were scored with the standards given by Brothwell (1981) and Bouts and Pot (1989). Morphometric sex and age determination was impossible since too many reliable points of measurement were missing. Great help and suggestions for the analyses were provided by S. Baetsen (Leiden).

The mingling of the material was so great, that it turned out to be impossible to determine exactly what skeletal elements belonged to which individual. Therefore, it was decided to describe the material not per individual but per findnumber. However, three individuals could be clearly distinguished on the basis of the occurrence of three distinct pairs of humeri[62], and three distinct right mandibula halfs.

[62] Samples of the humeri were sent to the National Museum of Natural History in Gainesville (Florida) for stable isotope analyses.

4.7.3 Results of the analysis of the human skeletal remains

4.7.3.1 Burial 1

Burial 1 provided a rather mixed up collection of skeletal remains. It contained fragments of the epistrophus, humeri, ulnae, radii, right femur and right collum femoris, left patella, calcaneus, left tibia, and both the fibulae. Furthermore, it contained fragments of cranium, maxilla, mandibula, two distinct pelves, right clavicula, left scapula, and the left femur. Finally, undeterminable fragments of costae, vertebrae, phalanxes, metatarsals, and metacarpals were found. It should be remarked that burial 1 provided also two extra left tibiae, of which the largest probably belongs to burial 1a.

As for the sex indicators, pelvis fragments belonging to two different individuals could be studied, together with the fragments of one cranium. The first pelvis provided four features that could be scored (table 38, page 156). Sulcus praeauricularis, incisura ischiadica major, arc composé, and corpus ischii scored respectively +1, 0, +1, and +1. These scores resulted in a degree of sexualization[63] of +0.7 masculine. The second pelvis provided two features that could be scored (table 39, page 156). Sulcus praeauricularis and incisura ischiadica major scored respectively +1 and +2. These scores resulted in a degree of sexualization of +1.5 masculine. A total of five cranial features could be scored (table 40, page 156). Arcus superciliaris, os zygomaticum, general impression of the mandibula, angulus mandibulae, and margo inferior mandibulae scored respectively 0, +1, +2, +2, and +1. These scores resulted in a degree of sexualization of +1.3 masculine.

The maxilla and, to a lesser extent, the mandibula provide information on the dental health of burial 1. The dental health for this individual was good. A total of 22 teeth had been erupted of which 13 elements could be inspected. None of the teeth had been lost Ante Mortem, and a total of nine elements had been lost Post Mortem. No traces could be found for caries, alveolarian atrophy, or periodontitis. Only a very modest calculus threatened the teeth. The attrition of the four remaining upper molars was attributed to phases 3, 3^+, 3^+, and 3. The three remaining upper pre-molars could all be attributed to phase 2, and the only remaining upper canine was scored phase 4. Of the lower teeth, two molars, one pre-molar, and two incisors were scored to phases 3, 3^+, 2^+, 4, and 4. On the basis of these results, the age at death might be estimated very carefully to 40 to 50 years (Brothwell 1981). However, without confirmation of other age indicators, which are lacking for this individual, this estimation is rather unreliable.

---

63 $\frac{\Sigma(WxX)}{\Sigma W}$

pelvic 1 features	weight (W)	score (X)	W x X
sulcus praeauricularis	3	+1	+3
incisura ischiadica major	3	0	0
arc composé	2	+1	+2
corpus ischii	2	+1	+2
Σ	10		+7

Table 38. Pelvic 1 features of Petite Rivière burial 1

pelvic 2 features	weight (W)	score (X)	W x X
sulcus praeauricularis	3	+1	+3
incisura ischiadica major	3	+2	+6
Σ	6		+9

Table 39. Pelvic 2 features of Petite Rivière burial 1

cranial features	weight (W)	score (X)	W x X
arcus superciliaris	2	0	0
os zygomaticum	2	+1	+2
mandibula (generalis)	3	+2	+6
angulus mandibulae	2	+2	+4
margo inferior mandibulae	1	+1	+1
Σ	10		+13

Table 40. Cranial features of Petite Rivière burial 1

4.7.3.2 Burial 1a

Burial 1a is rather complete. It contained a large part of the cranium, and a fragment of the right mandibula. It also contained the atlas, claviculae, humeri, ulnae, right radius, right patella, the right calcaneus, and fragments of scapulae, costae, vertebrae, phalanxes, metatarsals, and metacarpals.

As for the sex indicators, only cranial features could be scored (table 41, page 157). Glabella, arcus superciliaris, tubera frontalia and parietalia, inclinatio frontalis, processus mastoideus, planum nuchae, processus occipitalis externa, os zygomaticum, crista supramastoideus, and the angulus

mandibulae scored respectively +2, +1, 0, +1, +2, +1, +1, +1, -1, and +1. These scores resulted in a degree of sexualization of +1 masculine.

Facies symphysialis pubis, proximal femur epiphysis, and proximal humerus epiphysis were lacking as age indicators. Endo-cranial suture-obliteration could not be studied due to bad conservation and therefore, exo-cranial suture-obliteration (Herrmann et al. 1990:67) was studied. Only the sutura sagittalis could be scored. The pars verticis was scored as closing, referring to an age of 30 to 50 years old. The pars obelica was scored as closed, referring to an age of 20 to 40 years old, and the pars lambdica was scored as closing, referring to an age of 30 to 50 years old. The age at death can therefore be estimated at approximately 26 to 46 years.

The dental health was not clear. Only five dental elements were found that could not be correlated to the maxilla or mandibula. Two pre-molars belonged to a maxilla, and two pre-molars and one incisor belonged to a mandibula. The pre-molars from the maxilla were not damaged by attrition. One of them showed a modest degree of calculus, and very modest caries on the occlusal surface. Degrees of attrition could be assigned to phase 1 for both of the elements. One of the pre-molars of the mandibula was damaged by attrition. The incisor showed much calculus, and was severely damaged by attrition. The degrees of attrition could be assigned to phase 1 and 2^{+} for the pre-molars, and to phase 3^{-} for the incisor.

As for pathological features, an 'os wormianum' was encountered. The sutura lambdoidea, at the back side of the cranium, is followed by a double row of extra sutures, filled in with bone. This is not an anomaly but a congenital variation.

cranial features	weight (W)	score (X)	W x X
glabella	3	+2	+6
arcus superciliaris	2	+1	+2
tubera frontalis/parietalis	2	0	0
inclinatio frontalis	1	+1	+1
processus mastoideus	3	+2	+6
planum nuchae	3	+1	+3
processus occipitalis externa	2	+1	+2
os zygomaticum	2	+1	+2
crista supramastoideus	2	-1	-2
angulus mandibulae	2	+1	+2
Σ	22		22

Table 41. Cranial features of Petite Rivière burial 1a

4.7.3.3 Burial 1b

Burial 1b was a small individual. Very few fragments were conserved, except for an almost complete mandibula, fragments of os zygomaticum, orbita (too small to be used in the sex determination), right scapula, left clavicula, left ulna and radius, pelvis, femurs, tibiae, and fibulae. Furthermore, two almost complete humeri were present, together with undeterminable fragments of costae, vertebrae, phalanxes, metatarsals, and metacarpals.

As for the pelvic sex indicators, sulcus praeauricularis scored -2, which resulted in a degree of sexualization of -2 feminine (table 42). A total of four cranial features could be scored (table 43, page 159). The os zygomaticum, the general appearance of the mandibula, mentum, and the margo inferior mandibulae scored respectively -1, -1, 0, and +1. These scores resulted in a degree of sexualization of -2 feminine.

On the basis of the attrition of the teeth, it may be expected that this individual was rather old. Unfortunately, a more accurate assessment of the age at death could not be provided.

The dental status of the individual was unhealthy. The status of the lower teeth could be studied, as almost the complete mandibula was present. A total of nine elements were found that probably belong to an other individual. Of the 16 erupted teeth in the mandibula, 11 fragments were missing Ante Mortem, and five Post Mortem. Caries was found on one of the remaining elements. In the bone under the right canine a cavity had been caused by an abscess. Calculus and periodontitis were present but only in a modest stage. As for the degrees of attrition, four incisors were scored to phase 3^{+}, two canines were scored to phase 2^{-}, and one molar was scored to phase 3^{+}. Two unidentified teeth elements were scored to phases 5 and 6. A remarkable feature is that the lower teeth show a severe degree of caries on the necks of the teeth. This sort of caries does not often occur on these teeth. In general, this sort of caries is caused by the consumption of sticky, soft, non-abrasive, non-fibrous, and cariogen foods, that contain a lot of sugar (LePoole-Burnand personal communication 1995).

pelvic feature	weight (W)	score (X)	W x X
sulcus praeauricularis	3	-2	-6
Σ	3		-6

Table 42. Pelvic feature scores of Petite Rivière burial 1b

cranial features	weight (W)	score (X)	W x X
os zygomaticum	2	-1	-2
mandibula (generalis)	3	-1	-3
mentum	2	0	0
margo inferior mandibulae	1	+1	+1
Σ	8		-4

Table 43. Cranial feature scores of Petite Rivière burial 1b

4.7.4 Concluding remarks

The results can be summarized as follows. Burial 1 contained pelvic elements of two individuals, which could both be assigned to men. This assignment was confirmed by the analysis of the cranium, which also scored to be masculine. The age at death of one of the two individuals was estimated around 40 to 50 years. No pathological features were found. Burial 1a contained the skeletal remains of a man, whose age at death was approximately 26 to 46 years. The presence of an 'os wormianum' was the only pathological feature found for this burial. Burial 1b contained a limited quantity of skeletal material which had belonged to a rather small, older woman, whose age at death could not be estimated. She had suffered from a severe form of dental pathology.

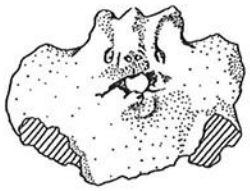
The dental health of the individuals is remarkable. Only one of them (burial 1b) has a very bad dental health. This individual had a high Ante Mortem tooth loss rate, and had suffered from an abscess, modest calculus and periodontitis, modest to severe attrition, and very severe caries on the necks of the teeth. Such bad dental health has often been reported for Amerindian pre-Columbian skeletal material, for example at the Maisabel site on Puerto Rico (Budinoff 1987), the Playa Blanca-5 site on Puerto Rico (Cashion-Lugo 1991), and at the Pointe de Caille site on St. Lucia (Reuer and Reuer-Fabrizii 1986:35). Cashion-Lugo (1991:833) contributed the occurrence of severe dental pathologies, including abscesses, caries, alveolar resorption and tooth loss, to the nature of the foods consumed, which must have been rich in carbohydrates, as well as the methods of preparation. According to Budinoff (1987:118), agents in the diet deteriorate the dental condition. These agents could include sand adhered to dried fish, shellfish, and land crab, hard substances, e.g. in land crabs, and foods rich in carbohydrates, manioc for example. Furthermore, heavy forms of attrition might also be contributed to the presence of grit, resulting from grinding procedures, in the food consumed. The two other individuals, however, have a good dental health, taken into consideration their age. The individual from burial 1 has not suffered from Ante Mortem

tooth loss, caries, alveolarian atrophy, or periodontitis. Calculus is only very modestly present, and the degree of attrition is modest to moderate. The individual from burial 1a had only a very slight degree of calculus, and caries. Attrition is non-existent to modest, and for only one element severe. These modest forms of attrition are comparable to those described for human skeletal remains of the Golden Rock site on St. Eustatius (Maat and Smits 1992).

Dramatic congenital, traumatic, or abrasive pathological features were not evidenced by the Petite Rivière skeletal material. Unfortunately, the size of the sample and the quality of the material do not allow demographic conclusions.

4.8 FINAL REMARK

In the preceding paragraphs, the archaeological materials were described that were found at the Petite Rivière site. These include pottery, stone artefacts, shell food remains and artefacts, coral fragments and artefacts, faunal remains, and human skeletal remains. They were analysed in a very descriptive manner. In chapter 5, they will be used, more analytically, in the second step of the three-phased subsistence research as proposed by Keegan (1987). This step includes the study of the information on subsistence that is provided by the archaeological record.



5 PRE-COLUMBIAN SUBSISTENCE AT THE PETITE RIVIÈRE SITE: A SYNTHESIS

5.1 INTRODUCTION

In this chapter, the subsistence system of the pre-Columbian inhabitants of the Petite Rivière site at La Désirade is examined. For this study, the following questions are considered important.

— Why were pre-Columbian Amerindians interested in the island of La Désirade?
— What natural subsistence and non-subsistence resources are available on the island and which might have been available at the time of interest?
— What sources can be archaeologically demonstrated to have been exploited?
— What was the subsistence system and diet of the pre-Columbian inhabitants of Petite Rivière like?

The objective of this chapter is to answer these questions through the application of the three-phased method of Keegan (1987) and Stokes (1995). First, the resources in the site's environs that might have been available and exploited in pre-Columbian times are identified with the help of Haviser's (1987[b], 1989, 1991) point-pattern technique (see paragraphs 1.3.2.4 and 1.4.2). Secondly, the archaeological record is studied for the information it puts forward on subsistence. For the Petite Rivière site, this record consists of pottery, stone artefacts, shell food remains and shell artefacts, coral artefacts, faunal remains, and human skeletal remains. Finally, the relative importances of natural resources are determined through analyses of stable isotopes on human skeletal remains. Limiting factors for this study are the small size of both the 1984 and 1995 excavation campaigns, and the lack of (paleo-)environmental information for La Désirade. As a result of these shortcomings, this study should be used and interpreted as an example of a small-scaled integrated subsistence study. No general or regionally applicable conclusions may be expected (see paragraphs 1.3.1-1.3.4.).

5.2 PREDICTIVE SITE CATCHMENT ANALYSIS

5.2.1 Introduction

Site catchment analyses have been criticized because of their deterministic character and because of impossibilities in the complete reconstruction of the landscape for the time of interest (e.g. Flannery 1976[c]). In this study, however, site catchment analysis will not be applied as a deterministic model, and no quantitative analyses will be made on the productivity of the catchment area. It is only used to specify a certain range of possibilities in which the pre-Columbian inhabitants of the site had free choice of how to use the environment and of what resources to exploit. Unfortunately, the environmental criticism can not be overcome completely in this study, although the thought is accepted that no great environmental and climatic changes have taken place the last 1500 years (see paragraph 2.3.2).

The first step in the present analysis is the identification of the area that might have been used by the inhabitants of the site. Secondly, it will be investigated what natural food and non-food resources might have been found in this area. For the first step, the thought is accepted that the areas most close to a site are the most likely to have been exploited, and that people probably followed a strategy based upon exploitation of a variety of resources with emphasis upon a few (Wing and Reitz 1982:27-28). The geographical characteristics and the resources of the identified area, such as elevation, geomorphology, geology, fresh water sources, soils suitable for cultivation, mangroves, tidal salt areas, access to marine resources, lithic and clay sources, and the presence of other pre-Columbian sites, are thought to influence the location of a site. They are quantified with a point-pattern analysis. Similar studies were executed for pre-Columbian sites on Bonaire and Curaçao (Haviser 1987[b], 1989, 1991).

5.2.2 Site catchment at the Petite Rivière site

Radii of 1, 2, 3, 4, and 5 km around the site were studied[64]. It must be remarked that circular areas are only symbolically representing the catchment area of a site. Actual catchment areas are determined by travelling time, the natural environment or cultural prescriptions. The steep hills leading to the plateau at La Désirade greatly influence the size of the travelling range. It requires

[64] This range was proposed by Vita-Finzi and Higgs (1970). Haviser (1991) studied circles with radii of 1, 2, and 3 km around the site. For pre-Columbian sites on Middle Caicos Island (Bahamas) territories with a radius of 1 km, appeared to have been exploited (Wing and Scudder 1987).

approximately half an hour for a trained person to climb them and to reach the plateau. Furthermore, the thought is accepted that in a canoe a distance of 5 km can be bridged in one hour.

In this study, both the circular catchment area as the one hour travelling range will be examined. The circular catchment area is represented by a total of 314 points, separated by 500 m intervals. The 0-1 km radius is represented by 14 points, the 1-2 km radius by 37 points, the 2-3 km radius by 62 points, the 3-4 km radius by 87 points, and the 4-5 km radius by 109 points. The travelling range, which is smaller than the 5 km range area, is represented by 251 points. For both areas, characteristics such as geomorphology, elevation, geology, resource areas, potable water sources, and adjacent sites, were quantified (tables 44 and 45, pages 172-173).

From a general observation of the total km range and the travelling range, it becomes clear that the open sea (52.3%) and hills (21.3%) are dominant. The plateau (14.3%) is also important in the general view of the area. Coastal environs, bays that are protected by reefs, the southern coastal plain, and hills, are represented by minor percentages, except for the first km range. The elevations (fig. 72a-b, page 164) are influenced by the geomorphology. Most of the travelling range is between 0-24 m (69.7%)[65], which represents the southern coastal plain. This plain extends via hills of 25-49 m (5.6%), 50-99 m (5.9%) and 100-199 m (8.4%) to the plateau, which has a height of 200 m and more (10.4%). These elevations are similar for the total km range area, except for the 0-1 km range, which is represented by larger percentages for elevations of 0-24 m (92.9%) and 25-49 m (7.1%).

For the geological features (fig. 73a-b, page 165), which may be indicative for lithic resource availability and potential vegetation zones (Haviser 1987[b]:102), a total of seven characteristics were scored. Marine environments ('other') are dominant in all ranges. The travelling range is mainly represented by the limestone covering (19.1%), which consists of uplifted coastal reefs and beaches, and of areas with inclusions and conglomerates of volcanic and plutonic elements. The north-east complex, consisting of radiolite and of deposits resulting from massif and sub-marine lava streams, is also well represented (17.5%). Beaches, deposits of non-consolidated debris[66] and silt, and the epi-metamorphic eruptif complex, are represented by minor percentages. A similar picture is found for the total km area. Minor variations occur in the separate km ranges, although the epi-metamorphic complex only occurs in the 2-3 and 4-5 km ranges, and a silt deposit in the 1-2 km range.

---

65 It must be remarked, however, that the 0-24 m range, without including marine environments, only represents 11.9%.

66 Beaches and deposits of non-consolidated debris may have changed since pre-Columbian times.

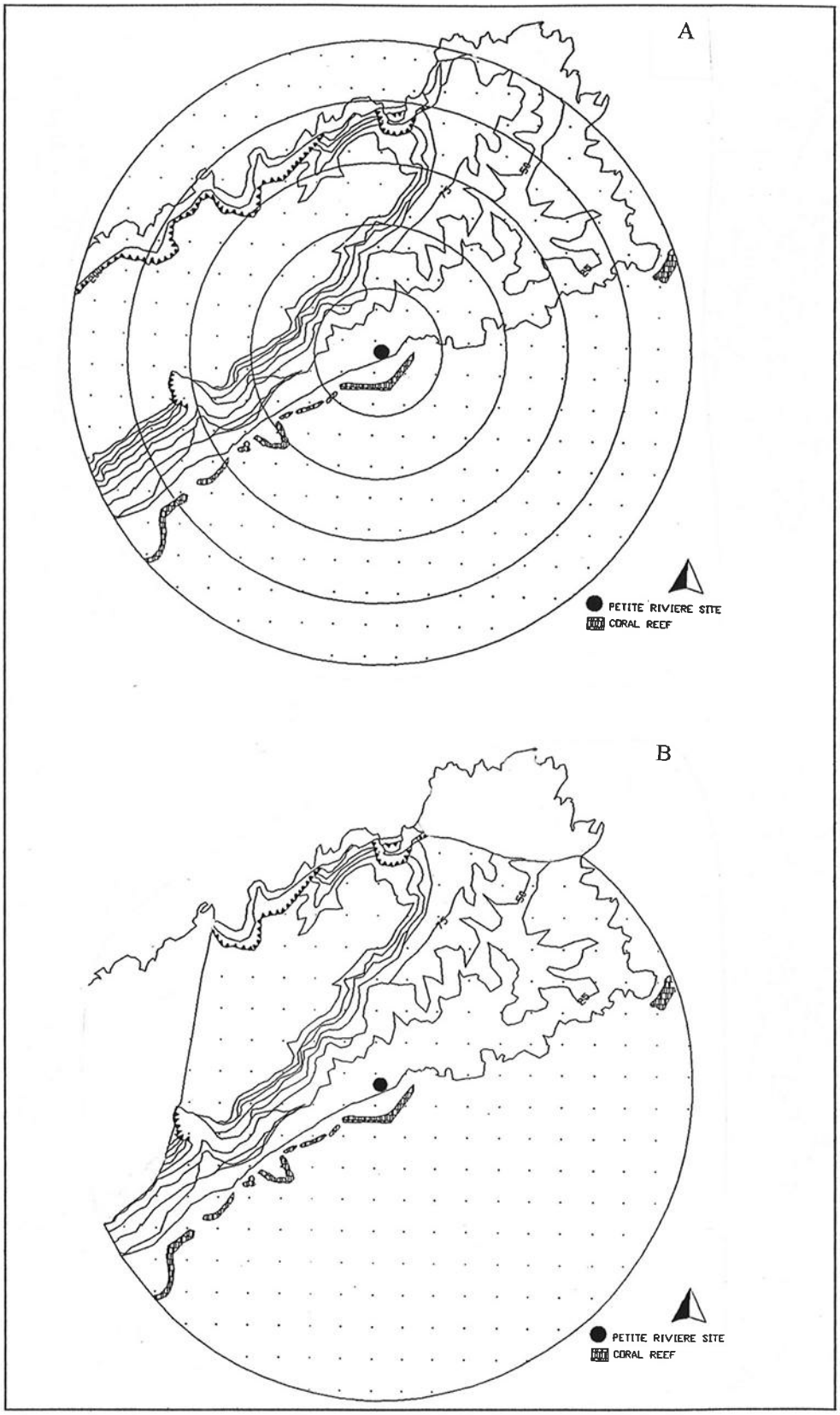


Figure 72. Elevations of the Petite Rivière catchment area: A. 5 km range; B. one hour walking range

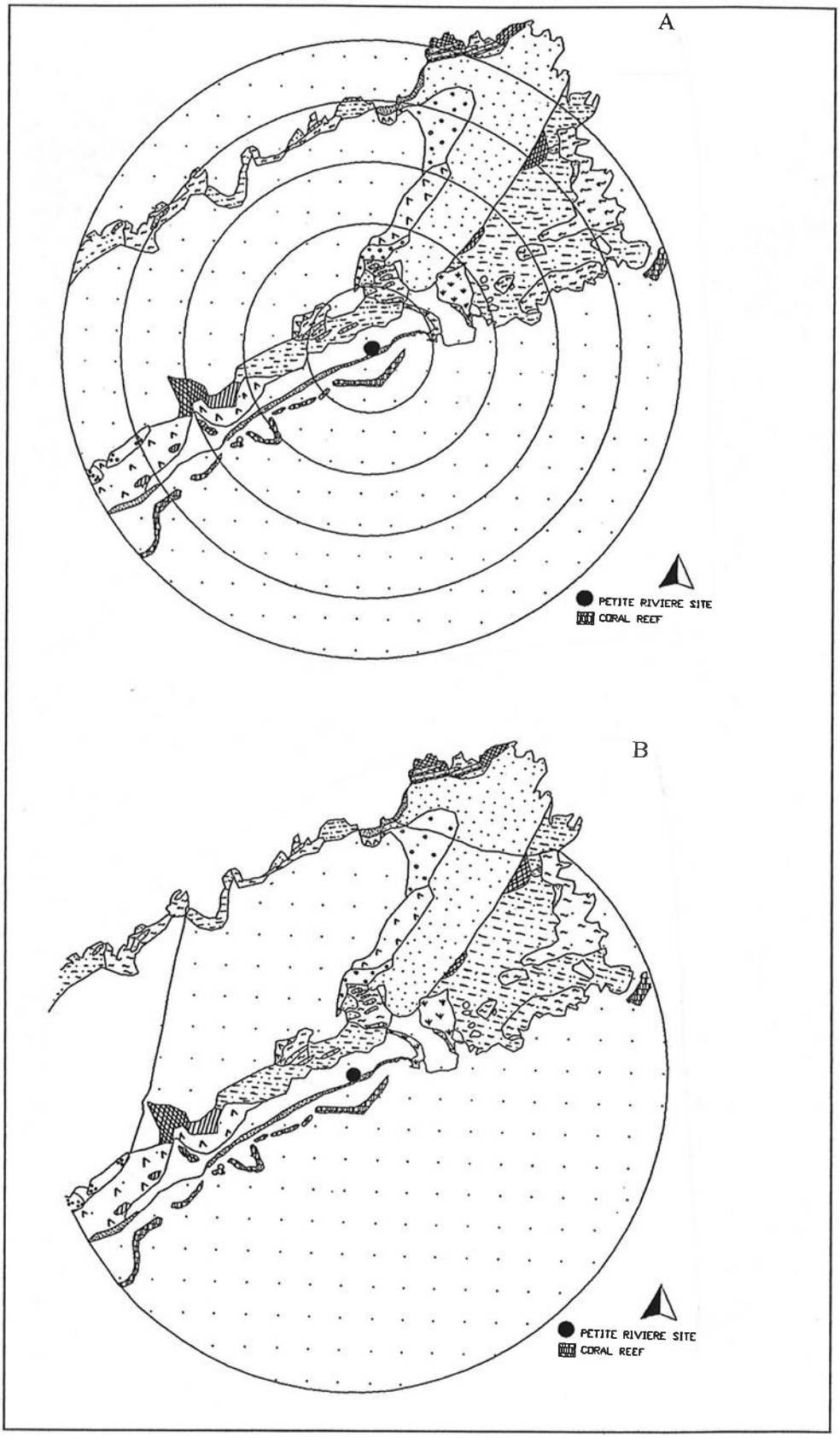
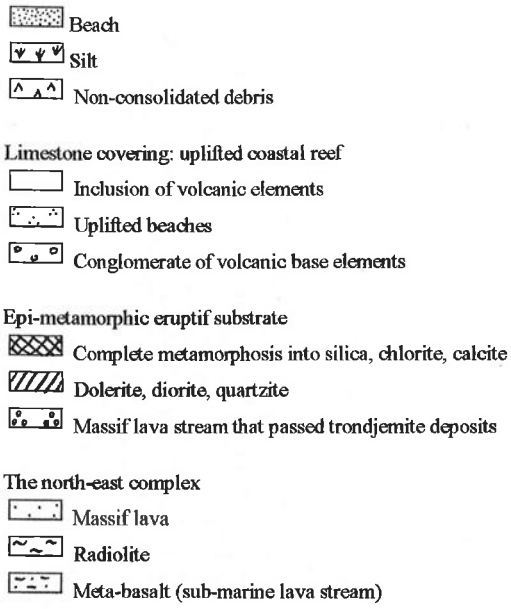


Figure 73. Geology of the Petite Rivière catchment area: A. 5 km range; B. one hour walking range



In order to get an idea of the resources that are present in the sample areas, a total of five features were scored. Resources that are considered to be important for a site's location are soils that are suitable for cultivation, mangroves, tidal salt areas, and clay sources. Marine environments form the largest category for all ranges. They are a very important resource since they provide marine food resources, and raw materials for the manufacture of shell and coral tools.

Mangroves are important for the natural occurrence of numerous varieties of shellfish, birds, crabs and other aquatic fauna (Haviser 1987[b]:4-6). Nowadays, marshy areas or mangrove swamps do not occur at La Désirade. The basic necessities for mangrove growth, such as a shallow sandy bottom bay area at a fresh water drainage basin where brackish water can stand, seem to be absent. It is possible that sea currents around the island are too strong to permit mangrove growth. Extensive mangrove rootsystems trap sediment and encourage further vegetation. They may accumulate so much sediment and peat that the area will become relatively dry land (Sealey 1992:54). Mangroves might have disappeared as a result of this accumulation process, but since the environmental and climatological factors do not seem to have changed a lot (see paragraphs 2.2.2 and 2.3.2), the existence of mangrove swamps in pre-Columbian times is not expected.

Salinas or tidal salt areas may have been important as a subsistence resource. Although it is not certain that the pre-Columbian inhabitants of the Windward Islands used salt as an additive to the basic diet[67] (Allaire 1991), they may have used salt as a preservative for meat (Haviser 1987[b]:4-6).

---

67 Ils n'ont pas accoustumé de se servir de sel pour assaisonner leur mets (Du Puis, F.M., 1825, *Relation de l'establissement d'une colonie françoise dans la Gardeloupe, isle de l'Amérique, et des moeurs des sauvages*).

At the west part of La Désirade, two salines can be found, but they fall outside the 5 km range. It is possible that, if salt was used, large quantities were obtained in single expeditions.

Clay sources are only represented by 0.3% of the total area. According to Haviser (1989:9), clay was not an important factor in settlement placement for pre-Columbian peoples. Nevertheless, they can be found near the site, in the silt deposit in the 1-2 km range. No clay samples from this deposit have been studied yet, so it remains unknown whether the Petite Rivière pottery was made out of this clay.

In order to estimate the quantity of land available for cultivation, the thought was accepted that only flat land, e.g. on the plain and the plateau, would have been cultivated (fig. 74a-b, page 168). On steep hills, the soils are less fertile as a result of erosion. Due to the scarcity of surface waters, the intense sun, and the high evaporation rate, possibilities for horticulture or agriculture are limited. For both the travelling area and for the total km range, soils suitable for cultivation are represented by approximately 23.0%.

The presence of faunal food resources, both terrestrial and marine, plays an important part in subsistence systems. The terrestrial fauna used by pre-Columbian Amerindians was restricted to insectivores, a few rodents, dogs, iguanas, and turtles (Wing and Reitz 1982:15). At La Désirade, the dryness greatly affects the flora and fauna. Most of the West Indies have a depauperate island fauna, and few indigenous land mammals will have been present, except for rather small species like iguanas. According to Haviser (1987[b]:133), such a situation will have led to a reliance on marine resources. Thus, site locations can be expected near accesses to marine resources. Especially the marine resources of the mangrove and coral reef systems are rich in protein (Allaire 1991). As mentioned above, mangrove swamps are absent at La Désirade, but a large coral reef stretches in the bay in front of the site. Here, rich food resources may have been found. The faunal assemblage that could have been hunted by the pre-Columbian inhabitants of the Petite Rivière site, might be considered as follows. Mammals, birds, and terrestrial reptiles could be hunted on the land, and laying sea turtles on the beach. The aquatic offshore banks produce snapper and grouper, while the aquatic inshore banks and reefs support porkfish, wrasses, parrotfish, surgeon fish, trigger fish, and porcupine fish. In the open sea (the pelagic habitat), tarpon, jack, barracuda, sheephead, flying fish, and large predacious pelagic fish such as tunas could have been predated (Wing 1968:103-104).

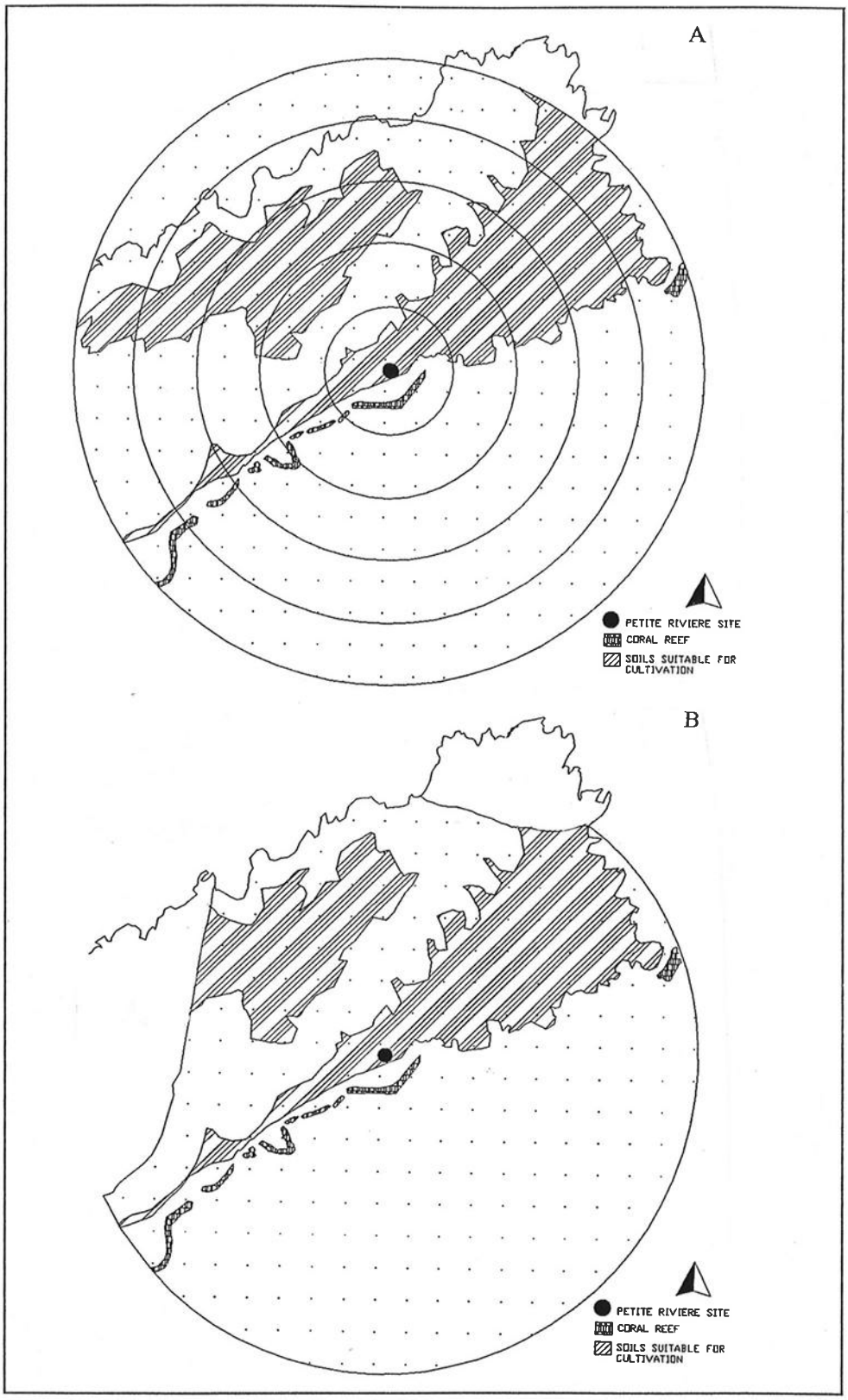


Figure 74. Soils suitable for cultivation of the Petite Rivière catchment area: A. 5 km range; B. one hour walking range

Availability of potable water sources is one of the most important conditions for human settlement. At the dry island of La Désirade this availability will have been rather limited. Most water sources that occur nowadays, are difficult to reach and their water outlets change with the seasons. A total of four potable water sources are located in the catchment areas (fig. 75a-b, page 170). Next to the site, a large fresh water source is situated. All sources fall within the travelling range, and every km range contained one source. The presence of fresh water is also a precondition for cultivation on a dry and desolate island as La Désirade. It may be remarked that three of the four fresh water sources are situated within or very close to soils that are suitable for cultivation. On the plateau, water from rainfall may have been contained naturally in the cavities in the limestone formations (see paragraph 2.2.1).

As for the adjacent archaeological sites (see also appendix 1), a total of eight sites were counted for both the travelling range and for the total km range (fig. 76a-b, page 171). Unfortunately, hardly any of them have been studied in detail and only a few radiocarbon dates have been obtained. Some of them can hardly be considered as archaeological sites, as they produced only one artefact, but they have been included in this count as they are known as such on the island. In the 0-1 km range, only the Petite Rivière site is present. In the 1-2 km range, the Léproserie site is situated. Only one Saladoid sherd was found here, and the function of the site is unknown. Within the 2-3 km range, a total of four archaeological sites are situated. On the plateau, the three sites of Morne Cybèle can be found. The Morne Cybèle-1 site was probably a permanent site. It produced post-Saladoid pottery, and a radiocarbon date of 1440-1480 cal AD. The site of Morne Cybèle-2 was probably also a permanent site, and it produced Suazan Troumassoid pottery, and a radiocarbon date of 1230-1326 cal AD (Hofman and Hoogland 1994). At the site of Morne Cybèle-3 only one ceramic base was found. No dates were obtained for this site and its function is unknown (Bodu 1984). On the southern coastal plain, the site of Morne Baie-Mahault is situated. It has been interpreted as a manufacturing site for local rocks (Bodu 1984). Unfortunately, no dates were obtained for this site. In the 3-4 km range, only the site of Le Cocoyer is situated. This site produced Late Saladoid material, but no radiocarbon dates were obtained. The function of the site is also unknown. Finally, in the 4-5 km range the sites of Pointe Doublé and Pointe Mansénillier are situated. During a survey of the latter site only one flint flake was found, thus the function and the dating of the site remains unknown. The Pointe Doublé site was interpreted as a manufacturing site for local rocks (Bodu 1984). No radiocarbon dates were obtained.

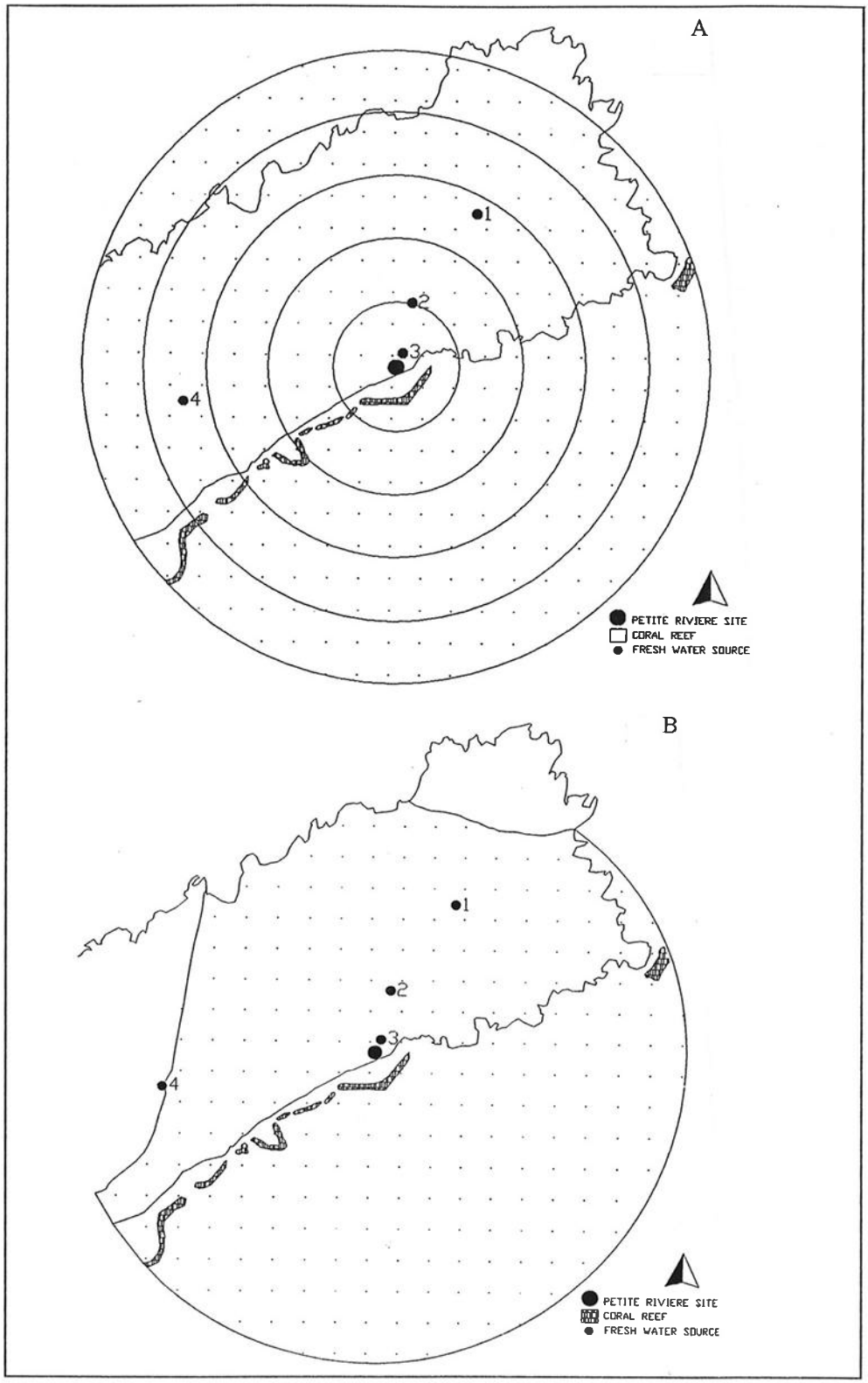


Figure 75. Fresh water sources of the Petite Rivière catchment area: A. 5 km range; B. one hour walking range. 1. Baie-Mahault, Grand-Savane; 2. Baie-Mahault, Ravine Bouille; 3. Baie-Mahault, Anse Petite Rivière; 4. Ravine Cybèle

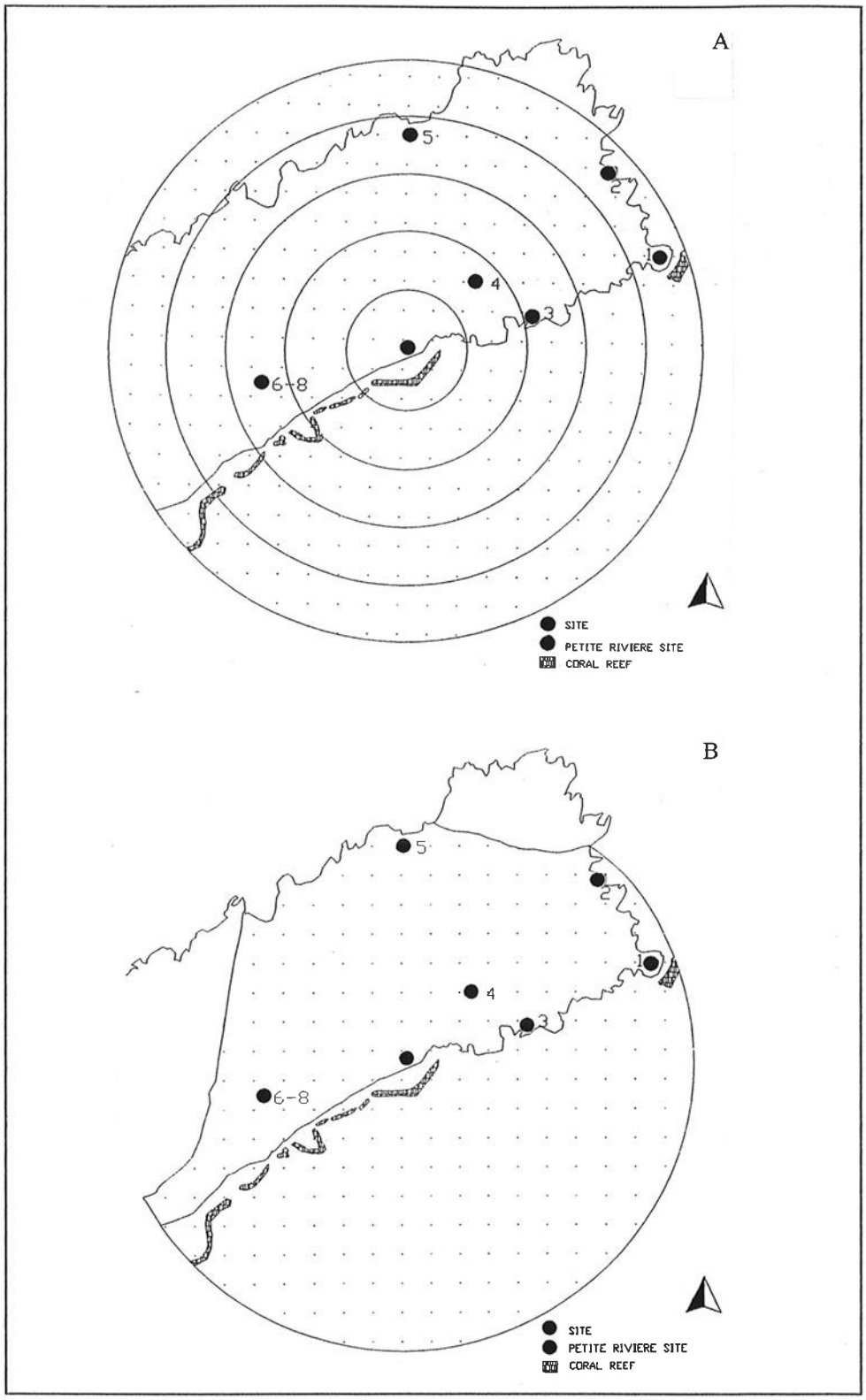


Figure 76. Archaeological sites in the Petite Rivière catchment area: A. 5 km range; B. one hour walking range. 1. Pointe Doublé; 2. Pointe Mansénillier; 3. Morne Maie Mahault; 4. Léproserie; 5. Le Cocoyer; 6-8. Morne Cybèle 1-3

	0-1 km radius N	%	1-2 km radius N	%	2-3 km radius N	%	3-4 km radius N	%
GEOMORPHOLOGY								
coastal	2	14.3	2	5.4	3	4.5	3	3.5
plain	3	21.4	4	10.8	4	5.9	1	1.2
hills	1	7.1	12	34.4	19	28.4	23	26.4
plateau			4	10.8	14	20.9	15	17.2
protected bay (reef)	2	14.3	1	2.7	1	1.5	2	2.3
open sea	6	42.9	14	35.9	26	38.8	43	49.4
total	14	100.0	37	100.0	67	100.0	87	100.0
ELEVATION								
0-24 m	13	92.9	21	56.8	34	50.8	44	50.6
25-49 m	1	7.1	4	10.8	3	4.5	4	4.6
50-99 m			2	5.4	7	10.5	2	2.3
100-199 m			6	16.2	6	8.9	23	26.4
>200 m			4	10.8	17	25.3	14	16.1
total	14	100.0	37	100.0	67	100.0	87	100.0
GEOLOGY								
beach	2	14.3			1	1.5		
non-consol. debris					3	4.5	2	2.3
silt			1	2.7				
limestone covering	2	14.3	12	32.4	17	25.4	30	34.5
epi-metamorphic					2	2.9		
N-E complex	3	21.4	9	24.3	19	28.4	15	17.2
other	7	50.0	15	40.6	25	37.3	40	45.9
total	14	100.0	37	100.0	67	100.0	87	100.0
RESOURCE AREAS								
soils for cultivation	6	42.9	13	35.1	23	34.3	20	22.9
mangroves								
tidal salt areas								
clay sources			1	2.7				
marine environments	8	57.1	23	62.2	44	65.7	67	77.1
total	14	100.0	37	100.0	67	100.0	87	100.0
POTABLE WATER SOURCES	1		1		1		1	
ADJACENT SITES[68]	S LS PS Unkn.		S LS PS Unkn.		S LS PS Unkn.		S LS PS Unkn.	
temporary						1		
permanent					2			
unknown type				1		1		1

Table 44. Petite Rivière catchment analysis results (after Haviser 1987[b])

[68] Saladoid, Late Saladoid, Post-Saladoid, and unknown date.

	4-5 km radius N	%	total area N	%	1 hour travelling time N	%
GEOMORPHOLOGY						
coastal	2	1.8	12	3.8	12	4.8
plain	4	3.7	16	5.1	17	6.8
hills	12	11.0	67	21.3	52	20.7
plateau	12	11.0	45	14.3	26	10.4
protected bay (reef)	4	3.7	10	3.2	10	3.9
open sea	75	68.8	164	52.3	134	53.4
total	109	100.0	314	100.0	251	100.0
ELEVATION						
0-24 m	83	76.2	195	62.1	175	69.7
25-49 m	4	3.7	16	5.1	14	5.6
50-99 m	9	8.3	20	6.4	15	5.9
100-199 m			35	11.2	21	8.4
>200 m	13	11.8	48	15.2	26	10.4
total	109	100.0	314	100.0	251	100.0
GEOLOGY						
beach	1	0.9	4	1.3	4	1.6
non-consol. debris	3	2.8	8	2.6	7	2.8
silt			1	0.3	1	0.4
limestone covering	13	11.9	74	23.6	48	19.1
epi-metamorphic	1	0.9	3	0.9	5	1.9
N-E complex	17	15.6	63	20.1	44	17.5
other	74	67.9	161	51.2	142	56.7
total	109	100.0	314	100.0	251	100.0
RESOURCE AREAS						
soils for cultivation	10	9.2	72	22.9	59	23.5
mangroves						
tidal salt areas						
clay sources			1	0.3	1	0.4
marine environments	99	90.8	241	76.8	191	76.1
total	109	100.0	314	100.0	251	100.0
POTABLE WATER SOURCES			4		4	

ADJACENT SITES	S	LS	PS	Unkn.	S	LS	PS	Unkn.	S	LS	PS	Unkn.
temporary			1				2				2	
permanent						2				2		
unknown type			1		1	3			1		3	

Table 45. Continuation of Petite Rivière catchment analysis results (after Haviser 1987[b])

5.2.3 Conclusions

From a general observation of both the travelling range and the total km range, is becomes clear that the distributions of the scored features are rather similar. Characteristic for the area directly around the site are the coastal environs, the protected bays, and the plain (0-24 m). Further removed from the site, the hills (25-199 m) and the plateau (>200 m) become more dominant. The open sea dominates the complete study area. These different environs may provide the resources that were used in pre-Columbian times.

Geologically, the area is dominated by the limestone covering, and the radiolite and lava deposits of the north-east complex. They may have provided raw materials for the manufacture of stone artefacts. They are easy to obtain and they are suitable for the manufacture of different tools.

As clay sources are present within 2 km of the site, they might be expected to have been used for the manufacture of ceramics. However, this hypothesis can not be tested, as no research has been done on the clay that was used for this pottery.

On the flat parts of the coastal plain and the plateau, and thus well in reach of the site, soils are situated that are expected to be suitable for cultivation. The quantity of cultivable land is large enough to create possibilities for horticulture and/or agriculture. La Désirade's poor soils are not thought to sustain maize cultivation, but manioc[69] flourishes on infertile soils. Root crops in general might very well have been cultivated as they do not require much of the soil. The soils on the plateau are known to be the best of the island. Even nowadays, agricultural fields can be found on the plateau. However, three of the four fresh water sources are situated in or very near the cultivable soils on the coastal plain, which renders them more likely to have been exploited. For cultivation on the plateau, use can be made of rain water that is conserved in the natural cavities in limestone formations. However, this supply will be limited and completely dependant on the weather.

The terrestrial fauna of La Désirade is expected to have been limited in pre-Columbian times, but the marine fauna must have been abundant. Therefore, subsistence can be expected to have been greatly depending on marine resources. In this respect, the predation and use of sea turtles, snapper, grouper, porkfish, wrasses, parrotfishes, surgeon fish, trigger fish, porcupine fish, tarpon, jack, barracuda, sheephead, flying fish, and large predacious pelagic fish may be expected. The predominance of marine resources is not a limiting factor in subsistence systems. Nearly all marine resources are aggregated or obtainable in large concentrations, which allows reduced search and retrieval costs. Shellfish may contain few calories, but marine diets can produce adequate protein to

[69] See Breton (1647) and De La Borde (1674) for information on Amerindian consumption of manioc.

supply coastal populations, and seafood is an excellent source of a number of vitamins (Yesner 1987:287-292).

It is not expected that the inhabitants of the Petite Rivière site had to share a lot of the available natural resources with inhabitants of contemporary sites. The only site in this catchment analysis that may have been permanent and more or less contemporaneous with the Petite Rivière site, is the site of Morne Cybèle-2. The inhabitants of this site had a fresh water source nearby, and cultivation was possible on the plateau. Geologically, the area around this site is completely dominated by the limestone covering of the plateau. For hard volcanic rocks, the inhabitants of this site were forced to go to the east part of the island where suitable raw materials for stone artefacts surface. Around the Morne Cybèle-2 site, no clay sources are known to exist, although decalcification clays occur in the limestone formation. Terrestrial fauna is thought to have been present on the plateau, but in order to acquire marine foods, the inhabitants of the site must have ascended from the plateau. Fragments of *Cittarium pica*, *Purpura patula* and *Nerita* sp. have been found during excavations of the site (Hofman 1995[a]). It is not expected that the inhabitants of both sites will have faced restrictions in the use of the available resources, as they are situated in rather different micro-environments, that offer enough possibilities to survive. The inhabitants of the Petite Rivière site may even have been able to find all required resources, except for clay sources, within 1 km around the site, and a broad-spectrum subsistence economy may have been possible.

5.3 INFORMATION ON SUBSISTENCE FROM THE ARCHAEOLOGICAL RECORD

5.3.1 Introduction

The excavations of the Petite Rivière site provided pottery, artefacts of stone, shell, and coral, skeletal human remains, waste products of shellfish gathering, and other faunal remains. They will be analysed for the information they provide on food procurement and preparation. First, the information on subsistence that is provided by the material culture and the human skeletal remains is studied. More direct evidence on pre-Columbian subsistence and diet is provided by the analysis of shellfish and other faunal remains. Finally, the information on the exploitation of non-subsistence resources is studied.

5.3.2 Information on subsistence from the material culture and human skeletal remains

Pre-Columbian land-clearing activities may be evidenced by stone, shell, or bone axes. At the Petite Rivière site, only one stone axe was found which had not been finished. Several shell axes were found, however, that could have served the same function. Other archaeological materials provide information on the processing of foods. Shell scrapers, for instance, may have been used to scrape organic soft material, and the coral artefacts were probably used for rubbing, rasping and grinding vegetable foods. Flint flakes may have been used for the processing of fish and vegetable foods. The presence of grinding stones is usually explained as evidence for the production and consumption of maize (e.g. Bullen 1964) or panicoid grass seeds (Newsom 1993). The presence of griddle fragments[70] might demonstrate manioc cultivation and production, the processing of wild indigenous roots and grains (Newsom 1993), or the processing of maize (DeBoer 1975). It may be expected that at Petite Rivière, grinding stones and griddles were used to process manioc or wild roots and grains, as at La Désirade the conditions for maize cultivation are not very suitable. These food resources were probably available on the cultivable soils (fig. 74a-b, page 168) near fresh water sources.

The excavated materials provide minor information on fishing technology. Only one possible fishing implement was found in the form of a shell hook.

Additional information may be provided by the study of human skeletal remains. The size and quality of the sample do not allow generalisations on demographic questions or health states. No dramatic congenital, traumatic, abrasive pathological features, or nutritional diseases were identified. The dental health of burial 1b does provide some nutritional information. This individual had suffered from a high Ante Mortem tooth loss rate, an abscess, calculus, periodontitis, attrition, and caries on the necks of the teeth. This type of caries is generally caused by the consumption of sticky, soft-textured, non-abrasive, non-fibrous, and cariogen foods, that contain a lot of sugar (LePoole-Burnand personal communication 1995). Similar dental states are often reported from pre-Columbian sites in the Caribbean, and they are usually explained through the consumption of foods, rich in carbohydrates (such as manioc), and through the methods of preparation, for instance from the presence of grit resulting from grinding procedures (Cashion-Lugo 1991:833), or from sand adhered to dried fish, shellfish, and land crab (Budinoff 1987:118). However, the dental health of the other two individuals is remarkably good, although grinding of foods and the consumption of manioc has been demonstrated on the basis of archaeological evidence.

---

70 Although most of the pottery probably functioned as a container or cooking pot for food, no residues were conserved to provide information on the nature of these nutrients.

5.3.3 Information on subsistence from the faunal and shell remains

Only a few shell species occur with abundant MNI at the Petite Rivière site, such as *Chiton* sp. (23.9%), *Cittarium pica* (18.9%), *Tegula* sp. (14.1%), *Nerita* sp. (13.5%), and *Nodilittorina tuberculata* (11.9%). It is remarkable that *Strombus gigas*[71] and bivalve species were hardly found. Other species were probably collected incidentally and selection among shell food resources seems to have taken place, although the size of the shells does not seem to have been a criterion. On the basis of dimensions, *Cittarium pica* and Chiton sp. may be considered to have been important in the subsistence system of the pre-Columbian inhabitants of the site. The above mentioned species can be found on and under rocks in intertidal areas, usually exposed to the open sea (*Chiton* sp., *Cittarium pica*, *Tegula* sp.), on rocks just above the high tide mark, and in rocky areas exposed to the open sea (*Nerita* sp., *Nodilittorina tuberculata*). The Petite Rivière bay near the site provides these habitats.

The most important contribution of vertebrate fauna to the diet consisted of fish. The vertebrate faunal remains of the Petite Rivière site represented 3.0% of mammals (rice rat), 2.1% of birds (passeriformes, pigeons and doves), 1.4% of reptiles (sea turtles, lizards, and iguana) and 81.2% of fish. Fish remains consisted of perch-like fish, sharks, rays, squirrelfish, groupers, snappers, grunts, porgies, parrotfish, bonefish, barracudas, surgeon-fish, trigger fish, and tuna and mackerel. Invertebrate remains (11.9%) include hermit crab, sea crab, land crab, and sea-urchin. The remainder of the sample could not be identified. The species in this assemblage can be found in different habitats, of which the aquatic habitat may be considered as the most important. The terrestrial habitat (5.7%) provided rice rat, other rodents, birds, lizard and iguana, hermit crab and land crab. The habitat of beach-turtle grass (0.7%) supported sea turtles. In various aquatic environments (44.7%) sharks, rays, perch-like species, and marine invertebrates can be found. The inshore-estuarine habitat (1.7%) supports porgies. The coral reef habitat (9.5%) provides squirrelfish, parrotfish, surgeonfish, bonefish, groupers, snappers, grunts and trigger fish, and finally, the offshore-pelagic habitat (0.4%) supports tuna, mackerel and barracudas. Herbivorous reef species (parrotfish and surgeonfish) are typically caught in traps nowadays as they will not take a hook. The other reef species, such as squirrelfish, groupers, snappers, grunts, bonefish, and trigger fish can be caught in traps but also with hook and line. Fish from the open sea (tuna, mackerel, and barracuda) may be caught with hook and line, or by dragnet fishing, but probably this did not often occur.

---

71 *Strombus gigas* remains might be underrepresented since the animals may have been removed at the beach, while the heavy shells were left on the coast. At the Petite Rivière site, however, only a distance of a few meters had to be made (see paragraph 4.4.3.2.1.).

5.3.4 Information on the exploitation of non-subsistence resources

Information on the exploitation of non-subsistence resources may be provided by the study of the raw materials used in the manufacture of artefacts. It may be clear that only durable materials, such as fired clay, stone, shell and coral survived in the archaeological record.

The clay that was used for the Petite Rivière pottery may have been found in the silt deposits at a distance of approximately 1 km from the site. However, no technological clay studies have been made yet, and clay occurrences at La Désirade have not been studied in detail. At the plateau, shallow and dispersed clay occurrences have been reported in the basins that were hollowed by carstification processes (Lasserre 1961[b]:889-890). It might be suggested that the pre-Columbian inhabitants of the Petite Rivière site were able to find suitable clays for their pottery near their settlement.

A non-food product which flourishes in arid environments is cotton. The cultivation and use of cotton in pre-Columbian contexts can be demonstrated by the occurrence of spindle whorls (Allaire 1991:7-9). The Petite Rivière terrain has been used as a cotton plantation in the past (Lallanne personal communication 1995), thus possibilities for the cultivation of cotton will have been present.

The most used raw materials for stone artefacts are basalt, sandstone, and flint. The other raw materials have more incidental occurrences. They occur naturally at La Désirade, near the site, and they can easily be obtained. Basalt, pumice, diorite, quartz, and granite can be found in the volcanic basement complex of the island, which surfaces in the eastern part of the island, and north of the site. Limestone, sandstone, flint, and radiolite deposits cover this volcanic basement, and they can be found on the whole island. Quartzite is known to occur near Grande Anse and Pointe du Désert, which is at the western part of the island.

Raw materials for the manufacture of shell tools and ornaments were *Strombus gigas*, *Cypraea* sp. and *Cittarium pica*. They could probably easily be collected in the Petite Rivière bay, near the site.

The pre-Columbian inhabitants of the Petite Rivière site also used coral fragments as raw material for tools, such as rasps and grinders. Most intensively used were *Acropora palmata* (51.5%) and *Acropora cervicornis* (36.6%). *Porites sp.*, *Siderastrea siderea*, and *Meandrina meandrites* were used to a lesser extent. These corals occur in the Petite Rivière bay, near the reef.

5.4 INFORMATION ON SUBSISTENCE FROM QUANTITATIVE ANALYSES

Stable isotope analyses (Keegan 1985, 1989[b]; Keegan and DeNiro 1988; van Klinken 1991; Stokes 1995) of human bone collagen refine the data on subsistence that are put forward by predictive analyses and the archaeological record, as they provide a direct measurement of the percentages of different food types in long-term consumption profiles. The most reliable analysis for the determination of the ratios of marine and terrestrial foods in diets of coastal populations is stable carbon- and nitrogen-isotope analysis. This analysis provides a lifetime profile of the average subsistence of an individual, but it may be questionable if this profile is representative for the average subsistence of the pre-Columbian inhabitants of an archaeological site. However, combination of the outcomes of stable isotope analyses and the archaeological evidence from a site will complete the view on subsistence. Archaeobotany combined with zooarchaeology and the study of shell food remains can then provide information about precisely which species of plants or animals contributed to the diet.

Samples of the humeri of the three Petite Rivière burials have been sent to the National Museum of Natural History in Gainesville (Florida) for stable carbon- and nitrogen-isotope analyses. The intention for having those analyses carried out was to obtain information on the percentages of the different food types consumed by the pre-Columbian inhabitants of the Petite Rivière site, and to complete these percentages with archaeological evidence about which terrestrial and marine faunal species did contribute to the diet. Unfortunately, the analyses were not finished in time, and therefore they could not be included in this study. As soon as the results will have arrived in the Netherlands, a more complete version of this study will appear, that also includes the results of the stable isotope analyses.

5.5 SYNTHESIS AND CONCLUSIONS

5.5.1 Results and conclusions

The area around the site is well accessible. It consists half of open sea, and the land is dominated by hills and the plateau. The area directly around the site, is even more accessible, and consists of coastal environs, the southern coastal plain, and bays protected by reefs. Most of the resources used probably were from this area. For the use of the open sea, the hills and the plateau, more effort was needed and their resources were probably used to a lesser extent. Next to the site, a large and

permanent fresh water source is situated, and at 1 km of the site another one can be found. Cultivation, especially extensive horticulture of roots and tubers, might have taken place near the site. Evidence for the cultivation of manioc and/or the use of wild indigenous roots and grains may be found in the artefacts that were encountered at the Petite Rivière site, and in the dental pathology of burial 1b. Cotton was probably also cultivated. Because of the poor island fauna (insectivores, rodents, dogs, iguanas, and sea turtles) that is characteristic for the West Indies, a heavy reliance on marine resources is predicted. Marine fauna occurring in the Petite Rivière bay, thus in rather shallow water, protected by a coral reef, may be expected to have been most used. These include a large range of shell species, including gastropods, bivalves, and chitons. The consumption of shellfish appeared to have been based on *Chiton* sp. and *Cittarium pica*. Bivalves and *Strombus gigas* were hardly found and selection seems to have taken place. Predicted fish species include snapper, grouper, porkfish, wrasses, parrotfish, surgeon fish, trigger fish, and porcupine fish. Fishing of mackerel, tarpon, jack, barracuda, sheephead, flying fish, and of large predacious pelagic fish such as tunas was also possible as a result of the near and accessible open sea. The consumption of vertebrate and invertebrate fauna appeared indeed to have been mainly focused on fish, and as predicted mainly on fish that occurs in various, inshore-estuarine, and coral reef habitats. Among these are perch-like fish, sharks, rays, porgies, parrotfish, surgeon-fish, squirrelfish, bonefish, groupers, snappers, grunts, and trigger fish. They may have been caught with traps, and with hook and line. Barracudas, tuna and mackerel from the offshore-pelagic habitat were probably only occasionally caught with hook and line, or by dragnet fishing. However, possibilities for pelagic fishing must have been present. Sea crab and sea-urchin were also found in small percentages. Terrestrial species, including rice rat, birds, sea turtles, lizard, iguana, hermit crab and land crab, had been used to a lesser extent. Although the suitability of Amerindian diet is often questioned, especially on the topic of animal protein, it may be generally accepted that Amerindian diets, even in a limited island environment, satisfied the subsistence needs of pre-Columbian communities. According to Dufour (1983) investigations among the Amazonian Agauruna demonstrate that the average diet of manioc and fish contains all required nutrients. This community is well-nourished. In early colonial times, the Caribbean pre-Columbian diet was also reported to satisfy the subsistence needs.

> "Les sauvages ne peuvent estre affamez, parceque leur habitations n'estât point fermées, si tost qu'ils apperçoivent le danger, ou qu'ils s'en méfient, ils se retirent dans les montagnes où ils ont des iardins pour cette necessité: outre que s'ils sont au bord de la mer, ils trouvent sur les roches ou sous les roches des *Belélheura*, *Ebépoulou*, *Mănbalia*, des Bourgos, & autres coquillages: peschent dans les rivieres des testars, des escreuisses, des petits escargots, qu'ils appellent *coulême*, que les font subsister. Ils connoissent dans les bois des arbres fruitiers, & des racines qui sont grosses comme la cuisse [ignames] qu'ils mangent mesme dans leur habitations" (Breton 1665:226).

For the non-subsistence resources, it may be predicted that the use of lithic resources relied mainly on limestone, and volcanic inclusions in the limestone bedrock. Most of the stone artefacts appeared to be made of basalt, sandstone and flint. Pumice, diorite, quartz, granite, limestone, radiolite, and quartzite had been used to a lesser extent. Clay deposits, which may have been used for the manufacture of pottery, were probably present near the site. Coral fragments and shells for the manufacture of artefacts may be expected to have originated mainly from the Petite Rivière bay. Shell species (*Strombus gigas*, *Cypraea* sp., *Cittarium pica*) and the coral species (*Acropora palmata*, *Acropora cervicornis*, *Porites* sp., *Siderastrea siderea*, *Meandrina meandrites*) that were used for the manufacture of artefacts could indeed have been collected here. The resources in the area directly around the site were probably not shared with inhabitants of contemporary sites.

It may be concluded that the data provided by the archaeological record are very similar to those put forward in the predictive phase.This might imply that the inhabitants mainly used those resources closest to their settlement and that the environment of the site was perfectly capable of supporting the inhabitants.

Now the research questions about the nature of the subsistence and non-subsistence resources available near the site, about what sources were actually exploited, and about the nature of the subsistence system and diet of the pre-Columbian inhabitants of Petite Rivière have been answered as detailed as possible, the last research question of why the pre-Columbian Amerindians were interested in the island of La Désirade may also be answered. In order to provide an answer, the question may be reversed: there was no reason why La Désirade or the terrain on which the Petite Rivière site is situated was not attractive for pre-Columbian settlement. The area is easily accessible, and it contains some different micro-environments (coastal plain, hills, plateau), each with its own characteristics. Next to the site, a large and permanent fresh water source is situated. Near the site, cultivation of manioc and cotton was possible and wild indigenous roots and grains may have been available. Vertebrate and invertebrate terrestrial and marine fauna could be found nearby. The nearby presence of lithic resources that are suitable for the manufacture of artefacts, of clay deposits, and deposits of other raw materials for artefacts such as shell and coral completed the attractiveness of the area. Moreover, there seems to have been no need of sharing subsistence resources with inhabitants of other contemporary sites. The situation of the Petite Rivière site might be compared to the Coralie site, an Ostionan Ostionoid site on Grand Turk (BWI). It was generally believed that this desert island in the condition it is now would be too dry to support a pre-Columbian population. Reconstructions revealed that the climate and vegetation of the island must have been very similar to modern day conditions. However, the pre-Columbian occupants were definitely choosing those islands for the riches they had to offer. Coralie proves that "very small

islands in pristine condition provide a bountiful and desirable location for pre-Columbian settlement" (Carlson 1995[b]).

No information has been gained, however, on the structures in which the inhabitants of the Petite Rivière site lived. As a result of the poor soils and the poor vegetation, a shortage of good construction wood may have occurred. Large-scale excavations might reveal information on structures and may thus be needed to investigate this problem. A shortage of woods may also have influenced the availability of canoes, and thus the possibilities for travel, transport, trade, exchange, and communication between groups on different islands.

5.5.2 Comparison with contemporary and other pre-Columbian sites in the Caribbean

It may sometimes be difficult to compare data from other sites because of uncertainties concerning the quality of the samples, sieving procedures, and the quantification of the material. However, it may be useful to study the results from other subsistence studies in the region in order to be able to evaluate the data from the Petite Rivière site. When comparing subsistence data, it can be concluded that the different dietary components correspond to the different environs that are represented around the island. For pre-Ceramic sites, however, no general pattern has been identified yet (Nokkert 1995).

In the Saladoid period both terrestrial and marine resources were exploited. A variety of subsistence strategies existed, each one reflecting local conditions, and depending on the correlation between site-location and the habitats exploited (Wing and Scudder 1980). The habitats near the sites that were most accessible were most exploited (Wing 1989). It may be wondered whether Saladoid groups located their settlement in the vicinity of specific habitats, or whether the location of the settlement determined the food exploitation patterns of the inhabitants (Nokkert 1995:72). Inland sites tend to contain more terrestrial vertebrate and land crab remains than coastal sites, e.g. the sites of Hope Estate on St. Martin (Wing 1995) and Cayon on St. Kitts (Wing and Scudder 1980). Coastal sites tend to have a more important marine component, e.g. the Golden Rock site on St. Eustatius (Versteeg and Schinkel 1992).

Reitz (1994:315) suggested that the ratios between the inshore, reef and pelagic fish species probably reflect the types of marine habitats around an island. At coastal sites on islands surrounded by restricted reef areas, deep reef and pelagic fish species are encountered, e.g at the Sugar Factory Pier site on St. Kitts (Wing and Scudder 1980) and the early Saladoid Trants site on Montserrat (Dukes and Reitz 1995). At coastal sites on islands with shallow waters and extensive reefs, species from these habitats are predominant.

A general decline in the exploitation of terrestrial resources has been observed in many late Saladoid sites, possibly as a result of over-exploitation by growing populations. This decline is often correlated to the shift observed from inland sites to coastal sites, and to the increasing exploitation of marine invertebrates (see paragraph 1.2.2).

For the post-Saladoid period on the Lesser Antilles few data on subsistence are available, although Troumassan Troumassoid and/or Suazan Troumassoid sites, that may have been more or less contemporary with the post-Saladoid component of the Petite Rivière site, have been reported over a large range of islands. Most of these sites are coastal and situated in dry and infertile environments. However, as the evidence of the Petite Rivière site points out, this is not necessarily a limiting factor for settlement, although it may restrict the possibilities for cultivation or the availability of terrestrial fauna. According to Allaire (1991:6-9), post-Saladoid subsistence is based on slash-and-burn cultivation of manioc, complemented by fishing and hunting. Manioc and other root crops such as sweet potatoes can very well be cultivated on dry and infertile soils, and cotton flourishes in arid environments. He even suggests the possibility of an intra-island trade of root crops, dried shellfish, fish, and possibly salt and cotton. Post-Saladoid subsistence data for the Lesser Antilles are provided by Allaire (1977, 1991), Drewett and Harris (1987), Drewett (1989, 1991, 1995), Cartwright (1991[b]), Wing (1991[b]), Hofman (1995[a]), Hoogland (1996), and Wing (1996). At the coastal Macabou site on Martinique, the subsistence system consisted of almost equal terrestrial and marine components. Fish remains included coral reef, inshore-estuarine and pelagic species (Allaire 1977).

On Barbados, the subsistence systems of four broadly contemporaneous Suazan Troumassoid sites (Hillcrest, Chancery Lane, Silver Sands, and Heywoods), each with access to a different complex of resources, were investigated. At these coastal sites, subsistence was focused on marine fauna. It consisted mainly of the capture of flyingfishes and tuna in pelagic waters, and the capture of fish in various aquatic habitats and parrotfishes and surgeonfish on the coral reefs. Evidence for the use of wild terrestrial species is scarce in these sites, except for the Silver Sands site, where 21% of the vertebrate remains consisted of wild terrestrial species. However, domestic dogs were present (Wing 1991[b]: tables 18-22).

Shellfish must have been a major source of protein (Drewett 1989). The shell refuse also reflects the different habitats surrounding the sites. Habitats near the Chancery Lane site consist of caves, marsh and sea. *Nerita* sp., *Cittarium pica*, *Strombus gigas*, *Chiton* sp., and *Chama* sp. are dominant here. Around the Silver Sands site, (freshwater) marsh and brackish areas, intertidal beach zones, coral reef and sea-bed habitats can be found. The shellfish remains found at this site consist predominantly of *Cittarium Pica*, *Nerita* sp., *Strombus gigas*, and *Chama* sp. Heywoods

and Hillcrest are near an intertidal zone with common rock-dwellers and near a coral reef zone. Their shellfish remains are dominated by *Strombus gigas* and *Cittarium pica* (Cartwright 1991[b]). A reconstruction of the pre-Columbian environment of Heywoods on the basis of plant remains demonstrates the presence of a rich mangrove swamp in a marine inlet (Drewett 1995). However, no mangrove shellfish species occurred in the sample.

A general subsistence image is created in which the pre-Columbian inhabitants of these sites are thought to have relied on cassava, fish from pelagic waters or coral reefs, shellfish from habitats near the site, terrestrial fauna and wild plants (Drewett and Harris 1987:185-186).

The inhabitants of the coastal Suazan Troumassoid site of Grande Anse, Terre de Bas, Les Saintes, relied predominantly on marine food resources. Shellfish species from rocks and sandy bottom and seagrass meadows in the direct vicinity of the site had been exploited, such as *Cittarium pica*, *Tectarius muricatus*, *Nerita* sp. and *Strombus gigas*. Fish remains consisted mainly of coral reef species, and terrestrial species were represented by smaller percentages (Hofman 1995[a]).

Fewer subsistence data are available for the Suazan Troumassoid sites of Morne Cybèle-1 and -2 on La Désirade. This may have been caused by less accurate sieving procedures[72] as a result of which small faunal remains may have been lost. The sites are situated atop the plateau, at a height of 205 m above sea-level. It is remarkable that fairly large amounts of shell had been transported to be prepared and consumed on the sites. At the Morne Cybèle-2 site shellfish remains were represented by *Cittarium pica*, *Purpura patula* and *Nerita* sp., and at the Morne Cybèle-1 site they consisted almost exclusively of *Cittarium pica* (Hofman 1995[a]).

Since the site location of both sites is unique, it would be interesting to study a sample of excavated material from both sites that has been wet-sieved over very small mesh sieves, in order to investigate the terrestrial component of the faunal remains. Moreover, MNI counts of both the shellfish remains and the other faunal remains should be provided in order to be able to distinguish the importance of the different habitats exploited, and to get an idea of the use and exploitation of the island by the pre-Columbian inhabitants of these remarkable sites.

Very detailed data on subsistence are available for the island of Saba. Faunal assemblages and carbon and nitrogen isotopes were studied for the sites of Spring Bay-1 and -3 (period 2: AD 850-1300[73]), and Kelbey's Ridge-1 (period 1: AD 400-850) and -2 (period 3: AD 1300-1400).

---

72 In 1984, the archaeological materials were probably collected by hand and not by sieving procedures. In 1994, the excavated material was dry-sieved over 10 mm mesh sieves.

73 See Hofman (1993) and Hoogland (1996)

In period 1, terrestrial animals (land crabs) are relatively abundant. Small rocky- or intertidal shellfish species (*Cittarium pica*, *Nerita* sp. and *Chiton* sp.) and inshore species (*Strombus gigas*) were abundant. Fishing on reef fish (parrotfish, triggerfish, grouper, snapper, hogfish, wrasses) was one of the main subsistence activities. In period 2, the dietary contribution of land crabs decreased and terrestrial vertebrates (rice rat, agouti, birds, and reptiles) show a slight increase. Shellfish remained important, and jacks and surgeonfishes increase in numbers, while parrotfishes and snappers are less abundant. Nitrogen values point to a diet dominated by marine resources, especially deep sea resources, which are related to the abundance of deep water. Assuming that no C_4 plants made part of the diet, although grinding stones were found, carbon isotopes suggest that the marine component might have been approximately 31%. In period 3, terrestrial vertebrates increase, especially rice rats, possibly as a result of more prominent agricultural and clearing activities. Shellfish gathering decreased, and fishing shifted from inshore waters to reef zones.

A general subsistence image is created in which pre-Columbian inhabitants of these sites are thought to have relied on manioc, resources from the rocky intertidal zone (*Nerita* sp. and *Chiton* sp.), fish, sea turtle, and to a lesser extent on terrestrial resources. The shift from exploitation of nearer shallow waters to more distant deeper waters was explained by overexploitation. Nitrogen isotopes point to a relative importance of deep-water resources in periods 2 and 3, which can be explained by the limited surface of shallow water around Saba. Shellfish contributed apparently in a lesser extent to the diet despite their abundance in the faunal assemblages. Carbon isotopes may suggest that during period 3 the mean marine component increased, horticulture intensified and maize was introduced (Hoogland 1996; Wing 1996).

It may be concluded that pre-Columbian Amerindians focused on the exploitation of the most abundant and accessible resources near their settlements. The sites of Morne Cybèle-1 and -2 are an exception to this rule, and they deserve to be studied in more detail, but the Petite Rivière site fits this general picture. Both terrestrial and marine resources were exploited, although the marine component is predominant, as a result of the coastal site location and the poor island fauna. The site is faced by a shallow bay with an extended coral reef, and shellfish and fish species from these habitats were exploited most intensively. In this respect, the assemblage of the Petite Rivière site is comparable to those of the sites of Hillcrest, Chancery Lane, Silver Sands, and Heywoods (Barbados), Grande Anse (Terre de Bas, Les Saintes), and Kelbey's Ridge-2 (Saba). However, intensive pelagic water fishing and the presence of domestic dogs from the sites on Barbados could not be demonstrated at the Petite Rivière site. Shellfish collecting was probably similar, although *Strombus gigas*, that is abundant on the other sites, was hardly encountered neither at Petite Rivière nor at Spring Bay-1 and -3, although this shell species could probably be found nearby.

5.5.3 Conclusions and abstract

In 1984 and 1995, archaeological excavations were carried out at the Petite Rivière site at La Désirade. The present study first serves as a report of the 1995 fieldwork. Secondly, it provides information concerning the natural subsistence and non-subsistence resources of the environs of the site, and the subsistence system and diet of it's pre-Columbian inhabitants. The study is limited by the small size of both the 1984 and the 1995 excavations, the lack of data concerning the 1984 fieldwork, the incompleteness of the faunal remains analysis, and the absence of the stable isotope analysis, which was not finished in time. This study can best be considered as a test-case for a small-scaled integrated subsistence study, without expecting larger scale conclusions and interpretations. First, it gives an introduction in Caribbean subsistence studies (chapter 1). Secondly, it provides information on the setting of La Désirade (chapter 2) and a report of the 1995 fieldwork at the Petite Rivière site, which consisted of a systematic surface survey and 13 shovel-tests (50x50 cm). The site appeared to consist of a shallow and rather disturbed archaeological layer. Radiocarbon dates ranging from 600-652 cal AD, 1012-1154 cal AD, and 1312-1402 cal AD were obtained (chapter 3). The excavations provided pottery, stone artefacts, shell food remains and shell artefacts, coral artefacts, faunal remains, and human skeletal remains. These categories have been described in detail (chapter 4). The pottery appeared to consist of a very small Late Saladoid component and a large post-Saladoid component, which may be correlated with the radiocarbon dates. The post-Saladoid component is characterized by unrestricted simple and restricted simple vessel shapes, rounded and inwardly thickened lip shapes, flat base shapes, wall thicknesses between 6-11 mm, orifice diameters between 21 and 30 cm, red, reddish-brown, and dark brown to very dark brown inner and outer surfaces that were predominantly highly burnished. Only 1.4% of the pottery was decorated, mostly by broad shallow incisions, and 15.8% was covered by a red slip or paint. The lithic assemblage, which is rather poor, consists of (waterworn) pebbles, grinding stones, rubbing stones, polishing stones, preforms, flakes, a flaked core, a flake tool, beads, and zemis. Suitable raw materials (mostly basalt, flint, and sandstone) could easily be obtained in the near surroundings of the site. Shell food remains consist mainly of *Chiton* sp., *Cittarium pica*, *Tegula* sp., *Nerita* sp., *Nodilittorina tuberculata*, and *Tectarius muricatus*. These species could easily be collected in the bay near the site. *Strombus gigas* and bivalves were hardly encountered, and selection seems to have taken place. Shell artefacts had been precisely worked, and they include scrapers, axes, a pointed tool, a fish hook, beads, a zemi, and unidentified objects. They were made out of *Strombus gigas*, *Cypraea* sp. and *Cittarium pica*, which could easily be collected in the Petite Rivière bay, near the site. Coral artefacts include *Acropora cervicornis* rasps, *Acropora palmata* grinders, *Porites porites* soft grinding or polishing tools, *Siderastrea siderea* grinders, and a *Meandrina meandrites* grinder. These coral species could easily be used as tools and could easily

be acquired as a result of their accessible habitats near the site. A minor percentage of the faunal remains consisted of mammals (*Oryzomyini* sp.), birds (Passeriformes and Columbidae), reptiles (Cheloniidae, Polychridae, *Iguana iguana*), and invertebrate remains (*Coenobita clypeatus*, *Calinestes* sp., land crab, and Echinoid). Fish remains are most abundant and they include perch-like fish, Carcharhinidae, *Aetobatis* sp., *Holocentrus* sp., Serranidae, *Lutjanus* sp., Haemulidae, Sparidae, Scaridae, Albulidae, Sphyraenidae, Acanthuridae, Balistidae, and Scombridae. The most important habitats were the various aquatic habitat and the coral reef habitat, where fish may have been caught with traps, nets or lines. Three human burials had been found in 1984. Two men (age at death: 40-50 years and 26-46 years) were found to have had a good dental health, and no pathological features, except for a congenital variation ('os wormianum') for one of them. A small and older woman was found to have suffered from severe dental pathologies, related to the consumption of sticky and cariogen foods.

In chapter 5, it was tried to identify the resources in the site's environs that might have been available and exploited in pre-Columbian times, with the help of a point-pattern site catchment analysis. Secondly, the archaeological record was studied for information on subsistence. Thirdly, the relative importance of food resources should be determined through stable isotope analyses, but these had not been finished in time. The site catchment analysis put forward that the area around the site is very accessible. It contains easily obtainable lithic, coral, and shell resources suitable for the manufacture of artefacts, a possible clay deposit, a large and permanent fresh water source, soils that are suitable for cultivation, and probably a depauperate terrestrial fauna but a rich marine fauna. Marine shellfish and fish occurring in shallow water, protected by a coral reef, may be expected to have been used most. These resources were probably not shared with inhabitants of other sites. The archaeological record provides evidence for a diet based on manioc and/or wild indigenous roots and grains, *Chiton* sp. and *Cittarium pica*, and fish from various, inshore-estuarine, and coral reef habitats, that may have been caught with traps, and with hook and line. Terrestrial species, including rodents, birds, sea turtles and other reptiles, and invertebrates were used to a lesser extent. It also evidences the use of non-subsistence resources, such as clay, cotton, and lithic, shell and coral resources for the manufacture of artefacts. The data from the archaeological record are similar to those from the catchment analysis. This implies that the inhabitants mainly used the nearest resources to their settlement, and that the environment of the site could support the inhabitants. The assemblage of the Petite Rivière site is comparable to the more or less contemporary sites of Hillcrest, Chancery Lane, Silver Sands, and Heywoods (Barbados), the site of Grande Anse (Terre de Bas, Les Saintes), and the site of Kelbey's Ridge-2 (Saba). The pre-Columbian inhabitants of these sites were mainly focusing on the exploitation of resources that were most abundantly and most accessibly available near their settlements.

5.5.5 Evaluation and suggestions for further research

More studies concerning subsistence in the post-Saladoid period in the Caribbean region will be needed in order to come to a better understanding of past human behaviour. As a result of the incomplete nature of the archaeological record, these studies require an interdisciplinary research approach.

An example of a small-scaled integrated subsistence study was executed for the Petite Rivière site at La Désirade. Considering this study as a test-case, without expecting conclusions that could be interpreted on a larger scale, its research method may be considered successful in recording subsistence data in a structured manner. It should not be forgotten that in the Caribbean, although the interest in studies of pre-Columbian subsistence and diet is growing, it is only a recent development that studies of all artefact categories are carried out. Disciplines like zooarchaeology and archaeobotany are such specialized and complicated fields of study that they are often used as a complete and independent researches in itself, and not as parts of integrated research programs.

For the Guadeloupe region, it would be interesting to execute a large-scale integrated subsistence study that includes more sites on La Désirade, Pointe-des-Châteaux, and the islands of Petite Terre, which all belong to the same continental platform. Research on the small islands of Petite Terre, located between Guadeloupe and La Désirade, should be interesting in particular. Neither artefacts nor detailed archaeological records are available, and it may be important to investigate whether the sites are settlements or resource extraction sites, and what resources were available and exploited. Such larger-scale study might provide data concerning the use of the environs of sites in different time periods, and also concerning the use of different environs for contemporary sites. To make such study a success, the following devices are important:

— Ethnohistoric reports and ethnographic analogies should be studied. Many early colonial reports exist for the French islands, providing information which is essential for our understanding of locally available food sources, and Amerindian procurement strategies and food preparation methods. Ethnographic analogies of tropical forest horticulturalists can provide general insights in the variety of ways people meet their subsistence needs.
— Zooarchaeological studies should identify faunal remains to the lowest taxonomic level possible, and MNI counts should be attained to allow frequency distributions and comparisons with other assemblages.
— Archaeobotanical studies should be included in the archaeological record, in order to obtain information on the past human use of plants, used as food, medicine, fuelwood, and raw material.

— Technological pottery studies may be executed in order to provide an insight in the origin of the clays used. Recently, clay samples from the plateau at La Désirade have been collected in order to be analysed in the laboratories of Leiden University (Hoogland personal communication 1996)
— Quantitative analyses in the form of stable carbon- and nitrogen-isotope analyses must be executed in time so that they can be included in the study. This is necessary in order to be able to determine the relative importance of natural resources in the diet.
— Larger-scale excavations (in comparison to the Petite Rivière excavations) are needed in order to provide a better quality and quantity of information on pre-Columbian subsistence and diet, and to reveal features relating to structures.
— More information on the (paleo)environment should be obtained, including information on coastal dynamics and changes in sea level, erosion, tectonic movements, and changes in climate, soils, and vegetation. Geomorphological studies combined with the study of early colonial descriptions may be suggested as a source of evidence. Some of the most prominent investigators of paleoclimatic changes in the Caribbean are working at the University of Florida, and are willing to help (Keegan personal communication 1996).
— As most archaeological research in this region has been small-scaled and poorly documented, better excavation reports and more detailed material studies must be made. Moreover, more reliable radiocarbon dates should be obtained. It would be best to have some general principles concerning sieving, sampling, and collecting procedures.
— More data are needed on site locations and subsistence systems of more or less contemporary sites (e.g. of the sites of Morne Cybèle-1 and -2).

If the above mentioned devices are followed, an interdisciplinary and integrated subsistence study on a large scale may provide structured information on pre-Columbian subsistence systems from different periods in the region, which may result in a better understanding of past human behaviour.

5.5.4 Conclusions et résumé

En 1984 et 1995, des fouilles archéologiques furent réalisées sur le site de Petite Rivière (La Désirade). Le présent ouvrage a pour but de fournir un rapport des fouilles de 1995, et obtenir des renseignements concernant les sources naturelles aux environs du site, et le système de la subsistance et le régime des habitants pré-Colombiens. L'étude fut limitée à cause de la petite échelle des fouilles, et du manque des renseignements concernant la fouille de 1984, des résultats des analyses des isotopes stables et d'une partie des résultats des analyses de la faune. Ces analyses ne furent pas terminées à temps. Mieux vaut considérer cet ouvrage comme un exercice d'une étude intégrée à petite échelle, sans attendre ni conclusions ni interprétations qui puissent être utilisées à plus grande échelle. D'abord, cet ouvrage fournit une introduction des études de la subsistance aux Antilles (1er chapitre). Ensuite, il fournit des renseignements sur le cadre de l'île de La Désirade (2^{e} chapitre) et d'un rapport des fouilles de 1995, qui consistaient d'une prospection en surface systématique et de la réalisation de 13 sondages (50x50 cm). La plus grande partie du site est représentée par une couche archéologique peu épaisse et remaniée. Des datations radiocarbon du site s'étendent entre 600-652 cal AD, 1012-1154 cal AD, et 1312-1402 cal AD (3^{e} chapitre). Les fouilles fournissent de la céramique, des artefacts lithiques, des restes alimentaires en coquillage, des artefacts en coquillage et en corail, des os d'origine animale, et des sépultures. Ces catégories furent décrites en détail (4^{e} chapitre). La céramique contient une composante Saladoïde tardive très limitée et une composante post-Saladoïde très abondante, qui pourraient être corrélées avec les datations. La composante post-Saladoïde est caractérisée par des formes ouvertes et de simples contours restreints ou non-restreints, des bords arrondis ou épaissis vers l'intérieur, des bases aplaties, des épaisseurs entre 6-11 mm, des diamètres entre 21-30 cm, des surfaces de couleur rouge, rouge brun, ou brun foncé vers brun très foncé, et des surfaces finies par brunissage intensif. Un pourcentage minime des tessons est décoré (1.4%), les motifs incisés larges et peu profonds étant les plus nombreux, et 15.8% des tessons furent finis avec un engobe ou une peinture rouge. Le mobilier lithique est assez pauvre et contient des galets (polis par l'eau), des pilons, des polissoirs, des pré-formes, des éclats, un nucléus, un outil présentant des traces de percussion, des perles, et des zémis. Parmi les roches les plus couramment rencontrées sont le basalte, le silex, et le grès, qui sont appropriés pour la fabrication des artefacts, et qui peuvent être trouvées facilement près du site. En ce qui concerne les restes alimentaires en coquillage, les espèces dominantes sont *Chiton* sp., *Cittarium pica*, *Tegula* sp., *Nerita* sp., *Nodilittorina tuberculata*, et *Tectarius muricatus*. Ces espèces pouvaient être collectionnées facilement à l'anse près du site. *Strombus gigas* et des bivalves furent trouvés à peine. Probablement des coquillages furent sélectionnés. Des artefacts en coquillage ont été travaillés avec grande précision. Ils consistent de grattoirs, de haches, d'un outil pointu, d'une hameçon, de perles, d'un zémi, et d'objets non-identifiés. Ils ont été faits de *Strombus*

gigas, *Cypraea* sp. et *Cittarium pica*, qui pouvaient être trouvés facilement près du site. Les artefacts en corail consistent de râpes en *Acropora cervicornis*, de meules en *Acropora palmata*, *Siderastrea siderea*, et *Meandrina meandrites*, et de polissoirs en *Porites porites*. Ces espèces pouvaient être travaillées facilement, et elles pouvaient être facilement acquisées grâce à leurs habitats accessibles près du site. Un pourcentage minime de restes alimentaires en os d'origine animale consiste de mammifères (*Oryzomyini* sp.), d'oiseaux (Passeriformes et Columbidae), de reptiles (Cheloniidae, Polychridae, et *Iguana iguana*) et d'invertèbres (*Coenobita clypeatus*, *Calinestes* sp., crabes de terre, et Echinoid). Des poissons sont les plus abondants (perciforme, Carcharhinidae, *Aetobatis* sp., *Holocentrus* sp., Serranidae, *Lutjanus* sp., Haemulidae, Sparidae, Scaridae, Albulidae, Sphyraenidae, Acanthuridae, Balistidae, et Scombridae). Les habitats les plus importants étaient l'habitat d'environs aquatiques divers et l'habitat du récif coralien, où des poissons pourraient être attrapés par piège, filet ou ligne. En 1984, trois sépultures furent trouvées. Deux hommes (âge de décès: 40-50 ans et 26-46 ans) avaient une bonne santé dentaire, et aucun fait pathologique ne fut trouvé, sauf une variation congénitale ('os wormianum') pour l'un d'entre deux. Une femme petite et âgée fut trouvée ayant souffert d'une pathologie dentaire sévère, qui peut être correlée à la consommation d'une nouriture collante et cariogène.

Dans le 5^{e} chapitre, il fut essayé d'identifier les ressources naturelles aux environs du site, qui pourraient être disponibles et exploitées dans la période pré-Colombienne ('point-pattern site catchment analysis'). Ensuite, des données archaéologiques furent étudiées pour obtenir des informations sur la subsistance. Finalement, les pourcentages des différentes ressources alimentaires seraient déterminés à l'aide d'analyses des isotopes stables, mais ces analyses ne furent pas terminées à temps. L'analyse de 'site catchment' démontrait que les environs du site sont très accessibles. Ils contiennent des ressources des pierres, des corails, et des coquillages, appropriés à la fabrication des artefacts, et qui peuvent êtres obtenus facilement, un dépot d'argile, une source d'eau potable permanente, des sols appropriés à la cultivation, une faune terrestre pauvre, et une faune marine riche. Des coquillages et des poissons qui trouvent leur gisement naturel dans des eaux peu profondes, protégés par un récif coralien, peuvent être supposés être les plus abondants. Probablement, il n'était pas nécessaire de partager ces ressources avec des habitants d'autres sites. Des données archéologiques pourvoient des indications pour un régime basé sur le manioc et/ou les tubercules et les céréales sauvages, *Chiton* sp. et *Cittarium pica*, et des poissons des habitats d'environs aquatiques divers, d'environs près du rivage-estuaire et de l'habitat du récif coralien, qui peuvent être attrapés par piège, hameçon et ligne. Des espèces terrestres furent moins exploitées. Elles démontrent aussi l'utilisation des autres ressources, comme l'argile, le coton, et de la pierre, des coquillages et des corails pour la fabrication des artefacts. Les données archéologiques sont pareilles aux données de l'analyse de 'site catchment'. Ça peut signifier que les habitants ont utilisé

principalement les ressources les plus proches de leur établissement, et que les environs du site pouvaient supporter ces habitants. L'assemblage du site de Petite Rivière peut être comparé avec les sites plus ou moins contemporains de Hillcrest, Chancery Lane, Silver Sands, et Heywoods (Barbados), le site de Grande Anse (Terre de Bas, Les Saintes), et le site de Kelbey's Ridge-2. Les habitants pré-Colombiens de ces sites se concentraient principalement sur l'exploitation des ressources qui étaient les plus abondantes et les plus proches de leurs établissements.

Plus d'études concernant la subsistance dans la période post-Saladoïde seront nécessaires pour mieux pouvoir comprendre la conduite humaine dans le passé. Résultant du caractère incomplet des assemblages archéologiques, ces études exigent une approche de recherche interdisciplinaire.

Un exemple d'une étude intégrée de la subsistance fut exécuté à petite échelle pour le site de Petite Rivière à La Désirade. Considérant cette étude comme un exercice, sans attendre des conclusions qui pouvaient être interprétées sur une plus grande échelle, sa méthode de recherche peut être considérée comme un succès pour l'enregistrement structuré des données concernant la subsistance. Il ne faut pas oublier que ce n'est que depuis récemment que des études de toutes les catégories d'artefacts sont faites dans la région Caraïbe, quoique l'intérêt pour des études de la subsistance et le régime pré-Columbien grandisse. Des disciplines comme la zooarchéologie et l'archéobotanie sont si spécialisées et complexes qu'elles sont considérées souvent comme une étude complète et indépendante au lieu d'une partie d'une étude intégrée.

Pour la région de la Guadeloupe, il serait intéressant d'exécuter une recherche intégrée à grande échelle concernant la subsistance, qui renferme plus de sites à La Désirade, à La Pointe-des-Châteaux, et aux îles de Petite Terre, qui font toutes partie de la même plateforme continentale. Particulièrement, des recherches dans les îles de Petite Terre, situées entre Guadeloupe et La Désirade, seraient intéressantes. Ni artefacts, ni rapports archéologiques détaillés ne sont disponibles, et il pourrait être important d'examiner si les sites étaient des habitations permanentes ou bien des sites qui servaient l'exploitation des ressources, et quelles ressources étaient disponibles et exploitées. Une telle étude à grande échelle, produirait des données concernant l'utilisation des environs des sites dans des périodes différentes, et aussi concernant l'utilisation des environs différents pour des sites contemporains. Pour faire une étude pareille un succès, les recommandations suivantes sont importantes:

— Des rapports ethnohistoriques et des analogies ethnographiques devraient être étudiés. Il y a beaucoup de rapports coloniaux anciens pour des îles françaises, qui produisent des renseignements essentiels pour notre notion des ressources alimentaires locales, et des stratégies amérindiennes de la collection et des méthodes de la préparation de la nourriture. Des analogies ethnographiques des horticulteurs de la forêt tropicale peuvent produire des reconnaissances générales concernant la subsistance.

— Des études zooarchéologiques devraient identifier des restes de la faune au niveau taxonomique le plus précis possible, et des comptes des 'minimum des nombres des individus' devraient être acquis pour pouvoir établir des schémas de fréquence et pour pouvoir faire des comparaisons avec d'autres assemblages.

— Des études archéobotaniques devraient faire partie de la recherche archéologique, pour obtenir des renseignements concernant l'utilisation des plantes, comme nourriture, médicament, bois de chauffage, et matière première, par l'homme dans le passé.

— Des études technologiques devraient être exécutées pour produire une notion des origines des argiles qui ont été utilisées pour la fabrication de la céramique. Récemment, des échantillons d'argile ont été collectionnés du plateau de La Désirade pour être analysés aux laboratoires de l'Université de Leiden (Hoogland communication personnelle 1996)

— Des analyses quantitatives sous forme d'analyses des isotopes stables de carbone et d'azote devraient faire partie de l'étude, pour pouvoir déterminer l'importance relative des ressources naturelles pour le régime.

— Des fouilles à plus grande échelle (en comparaison avec les fouilles de Petite Rivière) sont nécessaires pour fournir un meilleure qualité et une plus grande quantité de renseignements sur la subsistance et le régime pré-colombien, et de trouver des faits des structures de l'habitation.

— Plus de renseignements concernant les (paléo)environs devraient être obtenus, contenant des renseignements sur la dynamique côtière et les changements du niveau de la mer, l'érosion, les mouvements tectoniques, et les changements du climat, des sols et de la végétation. Des études géomorphologiques en combinaison avec l'étude des descriptions coloniales pourraient être suggérées comme source d'évidence. La plupart des explorateurs des changements paléoclimatologiques dans la région Caraïbe travaillent à l'Université de Floride, et ils ont consenti à coopérer (Keegan communications personnelles 1996).

— Comme la plupart des recherches archéologiques dans cette région étaient à petite échelle et à peine documentées, il faut que meilleurs rapports de fouilles et des études plus détaillées concernant les matériaux archéologiques soient faits, et que plus de datations radiocarbons soient obtenues. Le mieux serait d'avoir quelques principes généraux concernant les procédures de tamisage, d'échantillon, et de collection.

— Plus de données sont nécessaires concernant les locations des sites et des systèmes de la subsistance des sites plus ou moins contemporains (par exemple des sites de Morne Cybèle-1 et -2).

Si ces recommandations seront suivies, une étude interdisciplinaire et intégrée à grande échelle pourrait pourvoir des renseignements structurés concernant les systèmes de subsistance des périodes différentes dans la région, ce qui pourrait aboutir à une meilleure compréhension de la conduite humaine dans le passé.

APPENDICES

APPENDIX 1. THE ARCHAEOLOGICAL SITES OF LA DESIRADE (fig. 77a)

1 **Anse Petite Rivière**, Baie-Mahault. Coordinates 1806.500-711.800[74]; 11 m above sea-level. The site was discovered in 1950 by Barbotin and Clerc, and it was rediscovered in 1983 by bulldozer activities. The site was visited by Petitjean-Roget (1983), and excavated[75] by Bodu in 1984 and de Waal (this volume) in 1995. It was a coastal settlement with Late Saladoid and post-Saladoid 0components, and calibrated radiocarbon dates of AD 600-652, AD 1012-1154, and AD 1312-1402. Nowadays, it is threatened by erosion and building activities.

2 **A l'Escalier**, Le Souffleur. Coordinates 1804.600-709,400; 2 m above sea-level. This site was probably known to Barbotin and Clerc, and it was surveyed by Bodu in 1984, who reported a very dense concentration of surface finds of Saladoid material (1985[c]). It was a coastal settlement (10 m from the sea) of approximately 100 m^2. Nowadays, it is located in a sandy cultivated field, and it is disturbed and eroded.

3 **Morne Cybèle-1**, Le Souffleur. Coordinates 1806.100-710.600; 205 m above sea-level. The site was surveyed by Bodu in 1984 (1985[c]) and excavated by Hofman and Hoogland (1994). It was a plateau settlement of approximately 25 m^2, with post-Saladoid material and a calibrated radiocarbon date of AD 1440-1480. It is situated near a fresh water source, on a strategic location, dominating the south coast. It is partially disturbed by building constructions and threatened by the shallowness of the site, erosion and illegal sand exploitation.

4 **Morne Cybèle-2**, Le Souffleur. Coordinates 1806.100-710.500; 250 m above sea-level. The site was discovered in 1983. It was excavated by Bodu in 1984 (1985[a]) and Hofman and Hoogland (1994). It was a plateau settlement of approximately 150 m^2, with post-Saladoid (Suazan Troumassoid) pottery and a calibrated radiocarbon date of AD 1230 and 1326. The archaeological material was found in 10-20 cm deep natural depressions in the bedrock. Nowadays, the site is very eroded.

5 **Morne Cybèle-3**, Le Souffleur. Coordinates 1806.150-710.550; 205 m above sea-level. The site was discovered in 1984, between the Morne Cybèle-1 and Morne Cybèle-2 sites. It was surveyed by Bodu in 1984 (1985[c]), but only one Ceramic base was found.

---

74 La Désirade, Petite Terre, 1:20000, No 32.

75 Finds from legal surveys and excavations have been deposited in the depot of the archaeological Edgar Clerc Museum in Le Moule (Guadeloupe).

6 **Grotte le Baigneux**, Bourg de Grande Anse. Coordinates 1803.900-706.100; 15-20 m above sea-level. This site was discovered by the owner M. le Baigneur, at the slope of the plateau. He guards some shell and stone axes. It has not been visited by archaeologists and the date of the site is unknown (Bodu 1985[c]).

7 **Les Sables**, Grande Anse. Coordinates 1803.550-750.350; 1 m above sea-level. This site was discovered in 1984, excavated by Bodu in 1984 and 1985 (1985[b]), and visited by Hofman and Hoogland in 1994. It was a coastal settlement (80 m from the sea) of approximately 350 m^2. Saladoid material was found in an archaeological layer from 0-40 cm. The site is located at both sides of a road on cultivated land, which is property of J. Locquet. Shallow disturbance of the site has taken place as a result of cultivation and crab holes, and large-scale excavations are thought to be necessary (Hofman and Hoogland personal communication 1996).

8 **Pointe Mansénilier**, Baie Mahault. Coordinates 1807.800-713.600; 10 m above sea-level. The site was discovered and surveyed by Bodu in 1984 (1985[c]). The site appeared to be very eroded, and only one flint flake was found.

9 **Léproserie**, Baie Mahault. Coordinates 1806.900-712.500. The site, which is not surely a pre-Columbian site, was discovered and surveyed by Bodu in 1984. Only one Saladoid sherd was found.

10 **Pointe Doublé**, Baie Mahault. Coordinates 1807.250-713.800; 15-20 m above sea-level. The site was discovered and surveyed by Bodu (1984), and by de Waal in 1994. It probably was a manufacturing site for local rocks of approximately 400 m^2, on a rather abrupt slope to the sea. No dates were obtained.

11 **Morne Baie-Mahault**, Baie-Mahault. Coordinates 1806.750-712.850; 5-10 m above sea-level. The site was discovered and surveyed by Bodu (1984), and by de Waal in 1994. It probably was a manufacturing site for local rocks of approximately 300 m^2, on the slope of a hill near the sea. No dates were obtained.

12 **Le Cocoyer**, Baie-Mahault. Coordinates 1808.000- 711.500; 175 m above sea-level. The site was discovered and surveyed by Bodu in 1984 (1985[c]). He found Late Saladoid material. The site is located on the east-plateau, on semi-cultivated land, where it is lightly influenced by cultivation and erosion. Excavations do not seem to be urgent.

13 **Grotte de Grande Anse/Beauséjour**, Beauséjour. Coordinates 1803.9-706.000. This site was discovered and surveyed by Bodu in 1984 (1985[c]). It is property of N. Lauriette, and it is situated in a cave of approximately 20 m^2, at the border of a steep hill, with relatively easy access. Bodu found post-Saladoid material but also concluded that the site is too disturbed for an important excavation.

14 **Voûte à Pin**, Le Souffleur. Coordinates 1806.025-708.975; 180 m above sea-level. The site was discovered and partially destroyed by excavations by Father Guilbert, and it was surveyed by Bodu in 1984 (1985c). It is a cave, composed of two halls, dominating the river-bed at the bottom of a small steep cliff. Post-Saladoid material was found in limited quantities.

15 **Anse des Galets**, Beauséjour. Coordinates 1803.400-703.900; 20 to 35 m above sea-level. The site was discovered and surveyed by Bodu in 1984 (1985c). Saladoid material was found. It was a settlement dominating the sea, at the lower part of the abrupt coast, in the modest descent towards a ravine. Nowadays, it has been partly destroyed by vegetation and erosion.

16 **Tropique**, Grande Montagne, Beauséjour. Coordinates 1805.300-708.700; 240 m above sea-level. The site was known to Father Guilbert and it was rediscovered and surveyed by Bodu in 1984 (1985c). Post-Saladoid material was found. It was a settlement of approximately 400m^2, on the highest part of the plateau around a pool. It has been partly destroyed by erosion and by a road.

17 **Pointe à Godard**, Grande Anse. This site is located in a cultivated field at the border of the sea, and it contains Late Saladoid material.

THE ARCHAEOLOGICAL SITES OF PETITE TERRE DE DESIRADE (fig. 77b)

18 **Site du Phare**, Terre de bas. Coordinates 178.200-702.400; 6-7 m above sea-level. This site of approximately 12000 m^2 was known to Barbotin and Clerc, and it was surveyed by Bodu and Petitjean-Roget in 1985 (1985c). It is located on a hill (6 m) near a dry mangrove, and it is partly disturbed by illegal excavations.

19 **Baleine du Sud**, Terre de Bas. Coordinates 1788.800-701.800; 5 m above sea-level. This site was excavated by Nicholson (1975) and surveyed by Bodu in 1985 (1985c). They found post-Saladoid (Suazan Troumassoid) material. It was a coastal site of approximately 1000 m^2, near the central lagoon, partly on rocks and partly on sand (45 m behind a beach south of the harbour). The site has been lightly disturbed by erosion and illegal excavations.

20 **Trou Canard**, Terre de Bas. Coordinates 1789.800-701.800; 1.20 m above sea-level. This site was discovered and surveyed by Bodu in 1984 (1985c). He found post-Saladoid material. It was a coastal settlement, at the border of a sandy beach, bordered with stones. It has been partly destroyed by illegal excavations.

21 **Mouton de Bas**, Terre de Bas. Coordinates 1789.300-702.050; 1-6 m above sea-level. The site has been discovered and surveyed by Bodu in 1985 (1985c). He found a dispersed find concentration. The site is located near the small inundations in the inner part of the island.

22 **Est de Mouton de Bas**, Terre de Bas. Coordinates 1789.300-701.900; 50 cm above sea-level. It is a fossilized coastal site in the rocks at the border of the sea. It has been surveyed by Bodu in 1985 (1985°). It had been disturbed by fossilisation in rocks and erosion due to the sea. No finds have been collected.

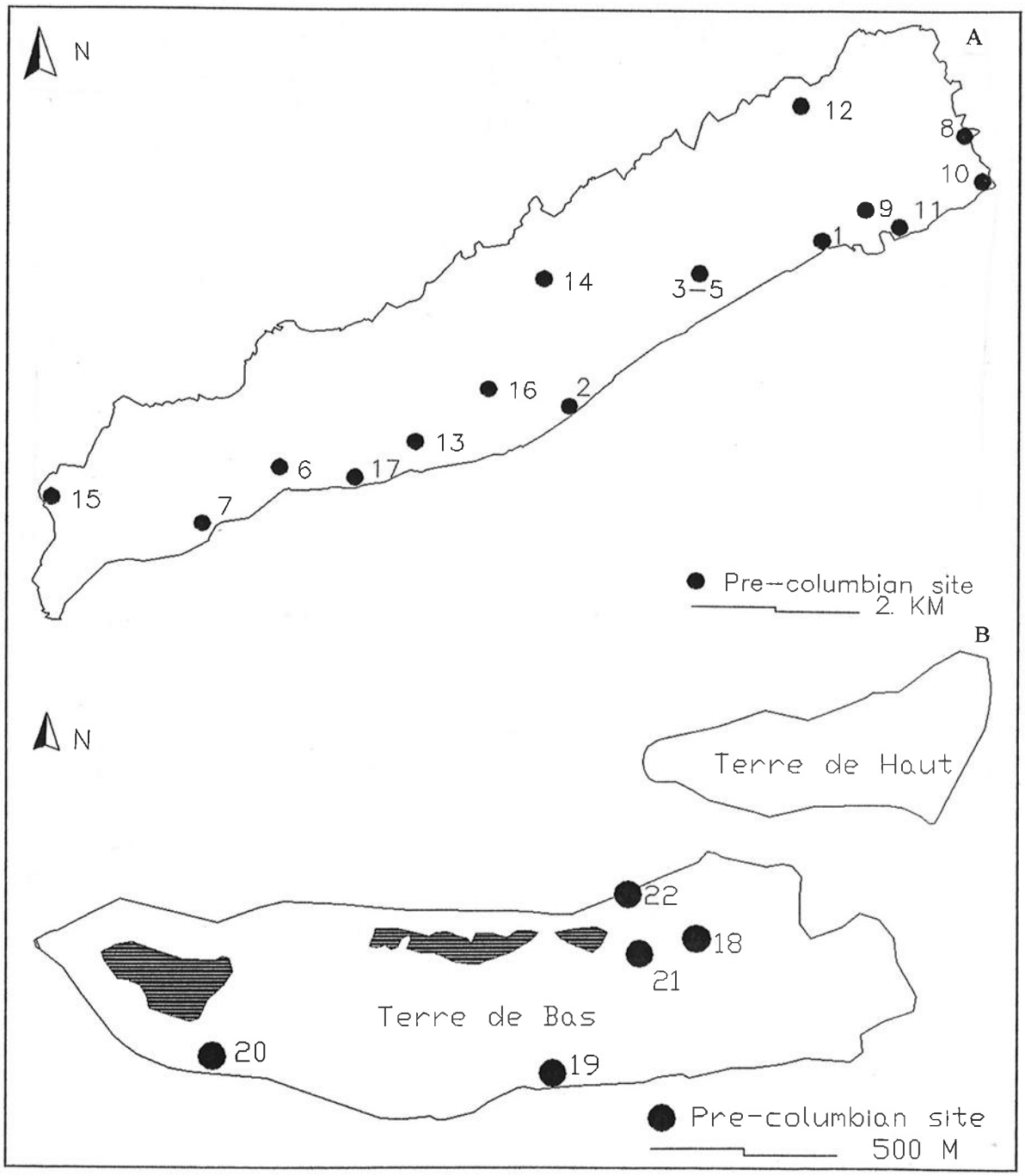


Figure 77. Pre-Columbian sites at La Désirade (A) and at Petite-Terre (B): 1. Anse Petite Rivière; 2. A L'Escalier; 3. Morne Cybèle-1; 4. Morne Cybèle-2; 5. Morne Cybèle-3; 6. Grotte le Baigneux; 7. Les Sables; 8. Pointe Mansénilier; 9. Léproserie; 10. Pointe Doublé; 11. Morne Baie-Mahault; 12. Le Cocoyer; 13. Grotte de Grande Anse/Beauséjour; 14. Voute à Pin; 15. Anse des Galets; 16. Tropique; 17. Pointe à Godard; 18. Site du Phare; 19. Baleine du Sud; 20. Trou Canard; 21. Mouton de Bas; 22. Est de Mouton de Bas

APPENDIX 2. PETITE RIVIERE FAUNAL REMAINS

VERTEBRATES taxon		skeletal part	N	Nburnt	weight(g)
MAMMALS					
Rodents	*Oryzomyini* sp.	tooth	1		
Rodents	*Oryzomyini* sp.	mandible	1		
Rodents	unident.	phalanx	13	2	
Rodents	unident.	left ulna	4	1	
Rodents	unident.	tarsal	3		
Rodents	unident.	costa	1		
Rodents	unident.	humerus	1		
Rodents	unident.	tibia	4		
Rodents	unident.	femur	3		
Rodents	unident.	long bones	23	3	
Rodents	unident.	epiphyse	4	3	
Rodents	unident.	pelvis	1	1	5.025
Unident.		unident.fragm	14		63.215
BIRDS					
Aves	unident.	long bones	46		
Aves	Passeriforme	phalanx	3		
Aves	Passeriforme	coracoid	1		
Aves	Passeriforme	pelvis	1		
Aves	Passeriforme	tibia	1		
Aves	Passeriforme	humerus	1		
Columbidae	unident.	coracoid	1		
REPTILES					
Cheloniidae	unident.	unident.fragm	11	2	
Cheloniidae	unident.	vertebra	4		
Polychridae	unident.	vertebra	9		
Iguanidae	*Iguana iguana*	vertebra	5		
FISH					
Unident.			*		177.065
Carcharhinidae		tooth	1		0.329
Myliobatidae	*Aetobatis narinari*	tooth	1		0.273
Holocentridae	*Holocentrus* sp.	quadrates	2	1	
Holocentridae	*Holocentrus* sp.	fragments	131	12	5.738
Perch-like		tooth	4		
Perch-like		maxilla	1		
Perch-like		otholith	6		
Perch-like		quadrates	7		
Perch-like		maxilla	9		
Perch-like		palate	7		
Perch-like		vertebra	1394	121	21.364
Serranidae		left premaxillary	1		
Serranidae		right premaxillary	4		1.906
Lutjanidae	*Lutjanus* sp.	left quadrates	1		
Lutjanidae	*Lutjanus* sp.	maxillairy	1		
Lutjanidae	*Lutjanus* sp.	left maxillary	2		
Lutjanidae	*Lutjanus* sp.	right maxillary	1		1.058
Haemulidae		left quadrates	2		
Haemulidae		left maxillary	4		
Haemulidae		right maxillary	3		
Haemulidae		left premaxillary	3		
Haemulidae		right premaxillary	2		
Haemulidae		tooth	2		2.046
Sparidae		tooth	3		
Sparidae		palate	13		
Sparidae		pre-maxillary	1		2.203
Scaridae		tooth	2		
Scaridae		palate	17		
Scaridae		internasal septum	4		
Scaridae		premaxillary	29	5	
Scaridae		quadrates	2		15.935
Sphyraenidae		tooth	1	1	0.275
Acanthuridae		left premaxillary	3		
Acanthuridae		right premaxillary	4		0.533
Balistidae		tooth	6		
Balistidae		quadrates	1	1	1.882
INVERTEBRATES					
Crab	unident.	fragments	90		
Crab	*Coenobita clypeatus*	pincer	56		
Crab	*Calinectes* sp.	pincer	78		
Crab	*Calinectes* sp.	fragments	6		
Crab	Land crab	pincer	14		
Crab	Land crab	fragments	15		
Echinoid	unident.	spine	23		
Echinoid	unident.	fragments	24		17.874
Total			2113	154	298.847

Table 46. Vertebrate and invertebrate remains from the 2.0 mm sieve residue of shovel 4, level 1 (After Grouard personal communication 1996)

VERTEBRATES taxon		skeletal part	N	Nburnt
REPTILES				
Polychridae	unident.	long bones	2	
Polychridae	unident.	tooth	1	
FISH				
Unident.		spine	76	16
Albulidae	*Albula vulpes*	vertebra	3	
Holocentridae	*Holocentrus* sp.	diverse	6	1
Perch-like		tooth	3	
Perch-like		otholith	1	
Perch-like		pharyngeal	54	
Perch-like		atlas	2	
Perch-like		vertebra	40	1
Balistidae		tooth	1	
Balistidae		vertebra	1	
Unident.	unident.	fragments	1	
INVERTEBRATES taxon		skeletal part	N	Nburnt
Crab	unident.	fragments		
Crab	unident.	pincer		
Echinoid	unident.	spine		
Echinoid	unident.	fragments		
Total			213	18

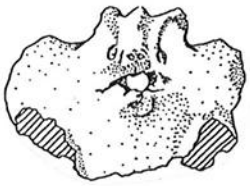
Table 47. Vertebrate and invertebrate remains from the 2.0 mm sieve residue of shovel 4, level 3 (After Grouard personal communication 1996)

VERTEBRATES taxon		skeletal part	N	Nburnt	weight (g)
MAMMALS					
Rodents	*Oryzomy* sp.	diverse	46	3	
BIRDS					
Aves	unident.	diverse	27	1	
REPTILES					
Cheloniidae	unident.	unident.	12	1	
Polychridae	unident.	vertebra	5		
Polychridae	unident.	mandible	5		
Iguanidae	*Iguana iguana*	vertebra	3		
Unident.	unident.	fragments	14		
FISH					
Unident.		spine	332	9	
Unident.		vertebra	620	29	
Unident.		pharyngeal	28		
Unident.		unident.	96	2	
Myliobatidae	*Aetobatis narinari*	vertebra	3		
Holocentridae	*Holocentrus* sp.	diverse	30	1	
Perch-like		pharyngeal	11	1	
Perch-like		atlas	20		
Perch-like		otolith	2		
Perch-like		tooth	1		
Perch-like		first spine	16	1	
Perch-like		cranium	15	1	
Perch-like		premaxillary	11		
Perch-like		scapula	4		
Perch-like		quadrates	4		
Perch-like		unident.cranial bone	45	8	
Serranidae			18		
Lutjanidae	*Lutjanus* sp.		3	2	
Lutjanidae	*Lutjanus* sp.	internasal septum	5		
Haemulidae			12		
Sparidae		premaxillary/maxillary	45		
Sparidae		diverse	7		
Scaridae		premaxillary/maxillary	5		
Scaridae		tooth	2		
Sphyraenidae			1		
Acanthuridae		spine	25		
Scombridae		vertebra	13		
Balistidae		vertebra	36		
Balistidae		spine	14	5	
Balistidae		tooth	2		
INVERTEBRATES taxon					
Crab	unident.		147		
Echinoid	unident.	spine	1		
Echinoid	unident.	fragments	3		
Total			1689	64	235.396

Table 48. Vertebrate and invertebrate remains from the 5.6 mm sieve residue of shovel 12, level 1 (After Grouard personal communication 1996)

VERTEBRATES taxon		skeletal part	N	Nburnt
Unident.fish	unident.	spine	1	
Unident.fish	unident.	vertebra	1	
Total			2	

Table 49. Vertebrate and invertebrate remains from the 5.6 mm sieve residue of shovel 12, level 2 (After Grouard personal communication 1996)



REFERENCES

Acsádi, G. and J. Nemeskéri

1970 *History of human life span and mortality*. Akademéniai Kiadó, Budapest

Allaire, L.

1974 An Archaeological Reconnaissance of St. Kitts, Leeward Islands. In: *Proceedings of the Fifth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:158-161

1977 *Later Prehistory in Martinique and the Island Caribs: Problems in Ethnic Identification*. Dissertation Yale University, Yale University Micro films, Ann Arbor

1984 A Reconstruction of Early Historical Island Carib Pottery. In: *Southern Archaeology* 3:121-133

1985 Changements Lithiques dans l'Archéologie de la Martinique. In: *Proceedings of the Tenth International Congress for the Study of the Pre-Columbian Cultures in the Lesser Antilles*:299-310

1991 Understanding Suazey. In: *Proceedings of the Thirteenth International Congress for Caribbean Archaeology*:715-728

1992 *The Late Ceramic Age in the Northeast Caribbean: The View from the Windward Islands*. Papers presented at the Symposium 'The Late Ceramic Age in the Northeast Caribbean'. 57th Annual Society for American Archaeology, Pittsburgh

Allaire, L. and D.T. Duval

1995 St. Vincent revisited. In: *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*:255-262

Armstrong, D.V.

1980 Shell-fish gatherers of St.Kitts: a study of Archaic subsistence and settlement patterns. In: *Proceedings of the Eight International Congress for the Study of Pre-Columbian Culture in the Lesser Antilles*:152-167

Barbotin, Père M.

1973 Tentative d'explication de la forme et du volume des haches precolombiennes de Marie-Galante et de quelques autres pierres. In: *Proceedings of the Fourth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:140-150

1991 Les Gisements de la Guadeloupe et les Grandes Lignes de leur Classement Chronologique. In: *Proceedings of the Twelfth International Congress of Caribbean Archaeology, Cayenne, French Guiana*:217-226

Bariteau, C.

1968 *Organisation économique et organisation familiale dans une île antillaise: La Désirade*. Thèse soumise à la Faculté des Sciences Sociales, Economiques et Politiques, Département d'Anthropologie, Montréal

Barrabé, L.

1942 La signification structurale de l'arc des Petites Antilles. In: *Bulletin de la Société Géologique de France*. Volume 12:147-159.

1954 Observations sur la constitution géologique de la Désirade (Guadeloupe). In: *Bulletin de la Société Géologique de France*. 6-ième série, Tome 3:613-626

Bloo, S.

in prep. Master thesis, Leiden University

Bodu, P.

1984 *Deux Ateliers de Débitage de Roches Locales en Désirade*. Le Moule

1985[a] *Rapport de Fouille de Sauvetage, Morne Cybèle, Le Souffleur, La Désirade*. Le Moule

1985[b] *Rapport de Fouille, Les Sables, Beauséjour, Désirade*. Le Moule

1985[c] *Rapport des Prospections en Surface, Désirade*. Le Moule

Boomert, A.

1986 The Cayo complex of St. Vincent. Ethnohistorical and Archaeological aspects of the Island-Carib Problem.In: *Antropologica* 66:3-68

1987 Notes on Barbados Prehistory. In: *Journal of the Barbados Museum* 37:8-43

Borde, de La, Sr.

1674 *Relation de l'origine, moeurs, coutumes, religion, guerres et voyages des Caraïbes, sauvages des Iles Antilles de l'Amerique*. Billaine, Paris

Bose, S.

1967 Carrying Capacity of Land under Shifting Cultivation. In: *The Asiatic Society Monograph Series*, Vol. 12. Calcutta

Bouchet, C.

1992 *Etude d'Impact, Port de Baie-Mahault, Désirade*. Pointe-à-Pitre

Bouts, W. and T. Pot

1989 *Burial archaeology, current research, methods and developments*. In: Roberts, C.A., F. Lee, J. Bintliff (eds.), BAR British Series 211

Breton, R.

1647 *Relations de L'île de la Guadeloupe, Tome 1.* Société d'Histoire de la Guadeloupe, Basse-Terre (1978 edition)

1665 *Dictionnaire Caraïbe-François.* Facsimile edition Teubner, Leipzig 1892

1666 *Dictionnaire François-Caraïbe.* Facsimile edition Teubner, Leipzig 1900

Brothwell, D.R

1981 *Digging up Bones.* Oxford

Budinoff, L.C.

1987 An Osteological Analysis of the Human Burials recovered from Maisabel: An Early Ceramic Site on the North Coast of Puerto Rico. In: *Proceedings of the Twelfth International Congress of Caribbean Archaeology, Cayenne, French Guiana*: 117-133

Bullen, R.P.

1964 *The Archaeology of Grenada, West Indies.* Contributions of the Florida State Museum, Social Sciences, No. 11. University of Florida, Gainesville

1970 The Archaeology of Grenada, West Indies, and the spread of ceramic people in the Antilles. In: *Proceedings of the Third International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:147-152

Bullen, R.P. and A.K. Bullen

1966 Three Indian Sites on St.Martin. In: *Nieuwe West Indische Gids* 45(2-3):137-144

1968[a] Barbados Archaeology: 1966. In: *Proceedings of the Second International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*: 134-144

1968[b] Salvage Archaeology at Caliviny Island, Grenada. A Problem in Typology. In: *Proceedings of the Second International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:31-43

1970 The Lavoutte site: A Carib Ceremonial Center. In: *Proceedings of the Third International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:61-86

1972 *Archaeological Investigations on St. Vincent and the Grenadines, West Indies.* William L. Bryant Foundation, American Studies, Report No. 8, Orlando

1973 Stratigraphic Tests at Two Sites on Guadeloupe. In: *Proceedings of the Fourth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:192-196

1974 Influences from Cultural Diffusion to Tower Hill, Jamaica and Cupecoy Bay, St. Martin. In: *Proceedings of the Fifth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:48-60

1976 Culture Areas and Climaxes in Antillean Prehistory. In: *Proceedings of the Sixth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:1-10

Bullen, A.K., R.P. Bullen and E.M. Branford

1973 The Giraudy Site, Beane Field, St. Lucia. In: *Proceedings of the Fourth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:199-214

Butterlin, J.

1956 *La Constitution Géologique et la Structure des Antilles*. Paris

Carbone, V.A.

1980 Some Problems in Cultural Paleoecology in the Caribbean Area. In: *Proceedings of the Eight International Congress for the Study of Pre-Columbian Cultures in the Lesser Antilles*:98-126

Carlson, B.

1995[a] Strings of Command: Manufacture and Utilization of Shell Beads among the Taino. In: *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*:97-109

1995[b] *The Coralie Site: Preliminary Excavations at an Ostionan Ostionoid Site on Grand Turk, B.W.I.* Paper presented at the 16th International Congress for Caribbean Archaeology, Guadeloupe

Cartwright, C.

1991[a] Shell Artifacts. In: Drewett, P.L. (ed.), *Prehistoric Barbados*:101-123. Archetype Publications Ltd., Wales

1991[b] Economy and Subsistence: Shellfish. In: Drewett, P.L. (ed.), *Prehistoric Barbados*:153-164. Archetype Publications Ltd., Wales

Cashion-Lugo, M.A.

1991 Stress indicators in an aboriginal sample from Playa Blanca-5 site, Ceiba, Puerto Rico. In: *Proceedings of the Thirteenth International Congress for Caribbean Archaeology*, part two:832-839

Chanlatte Baik, L.A.

1981 *La Hueca y Sorcé (Vieques, Puerto Rico): Primeras migraciónes agroalfareras Antillanas: Nuevo esquema para los procesos culturales de la arqueologia Antillana*. Santo Domingo

1983 Sorcé-Vieques: Climax cultural del Igneri y su participatión en los procesos socioculturales Antillanos. In: *Proceedings of the Ninth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:73-95

Clark, J.G.D.

1952 *Prehistoric Europe: the Economic Basis*. Methuen, London

Clarke, D.L.

1968 *Analytical Archaeology*. Methuen, London

Clerc, E.

1974 Le travail du coquillage dans les sites pre-Columbiens de la Grande Terre de Guadeloupe. In: *Proceedings of the Fifth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:127-132

Davis, D.D.

1974 Some Notes Concerning the Archaïc Occupation of Antigua. In: *Proceedings of the Fifth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:65-71

Davis, D.D. and R.Ch. Goodwin

1990 Island Carib origins: Evidence and Nonevidence. In: *American Antiquity* 55 (1): 37-48

DeBoer, W.R.

1975 The archaeological evidence for manioc cultivation: A cautionary note. In: *American Antiquity*:419-433

DeFrance, S. D.

1988 *Zooarchaeological investigations of subsistence strategies at the Maisabel Site, Puerto Rico*. Unpublished Master's Thesis, University of Florida, Gainesville

1989 Saladoid and Ostionoid Subsistence Adaptations: Zooarchaeological Data from a Coastal Occupation on Puerto Rico. In: Siegel, P.E. (ed.), *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*:57-78. BAR International Series, Oxford

Donnely, T.W.

1975 The Geological Evolution of the Caribbean and Gulf of Mexico. Some critical problems and areas. In: Nairn, A.E.M. and F.G. Stehli, *The Ocean Basins and Margins. Volume 3. The Gulf of Mexico and the Caribbean*:663-690. New York

Dufour, D.L.

1983 Nutrition in the Northwest Amazon: Household Dietary Intake and Time-Energy Expenditure. In: Hames, R.B. and W.T. Vickers, *Adaptive Responses of Native Amazonians*:329-356. Academic Press, New York

Drewett, P.L.

1989 Prehistoric Ceramic Population Lifeways and Adaptive Strategies on Barbados, Lesser Antilles. In: Siegel, P.E. (ed.), *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*:79-118

1991 *Prehistoric Barbados*. Archetype Publications Ltd., Wales

1995 Heywoods: Reconstructing a Preceramic and Late Landscape on Barbados. In: *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*:273-282

Drewett, P.L. and M.L. Harris

1987 The Archaeological Survey of Barbados: 1985-1987. In: *Proceedings of the Twelfth International Congress of Caribbean Archaeology, Cayenne, French Guiana*:175-202

Dukes, J.A. and E.J Reitz

1995 Use of Vertebrate Resources at Trants, A Saladoid Site on Montserrat. In: *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*:201-208

Fink, L.K.

1972 Bathymetric and Geologic Studies of the Guadeloupe Region, Lesser Antilles Island Arc. In: *Marine Geology*. Volume 12:267-288. Amsterdam

Flannery, K.V. (ed.)

1976[a] *The Early Mesoamerican Village*. Orlando

1976[b] The Village and its Catchment Area. In: Flannery, K.V. (ed.), *The Early Mesoamerican Village*:91-95

1976[c] Empirical Determination of Site Catchments in Oaxaca and Tehuacán. In: Flannery, K.V. (ed.), *The Early Mesoamerican Village*:103-117

Foz, P.J. and B.C. Heezen

1975 Geology of the Caribbean Crust. In: Nairn, A.E.M., and F.G., Stehli (eds.). *The Ocean Basins and Margins. Volume 3. The Gulf of Mexico and the Caribbean*:444-451. New York

Friesinger, H., E. Reuer, S. Reuer-Fabrizii, F.F. Steininger and P. Faupl

1986 *Grabungen und Forschungen auf St. Lucia, 1984*. Mitteilungen der prähistorischen Kommision der Osterreichischen Akademie der Wissenschaften. Vienna

Goodwin, R.C.

1979 *The Prehistoric Cultural Ecology of St. Kitts, West Indies: A Case Study in Island Archaeology*. Dissertation Arizona State University. University Microfilms, Ann Arbor

1980 Demographic change and the crab-shell dichotomy. In: *Proceedings of the Eight International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:45-68

Grouard, S.

In prep.Dissertation, University of Paris 1

Haag, W.G.

1965 Pottery Typology in Certain Lesser Antilles. In: *American Antiquity* 31(2): 242-245

1970 Stone Artefacts of the Lesser Antilles. In: *Proceedings of the Third International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:129-138

Hackenberger, S.

1986 An Abstract of Archaeological Investigations by the Barbados Museum, 1986. In: *Proceedings of the Twelfth International Congress of Caribbean Archaeology, Cayenne, French Guiana*:163-173

Harris, P.O'B.

1983 Antillean Axes/Adzes: Persistance of an Archaïc Tradition. In: *Proceedings of the Ninth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:257-290

Harris, M. and E.B. Ross (eds.)

1987 *Food and Evolution, Toward a Theory of Human Food Habits*. Philadelphia

Harris, M.H.

1991[a] Material culture: Pottery. In: Drewett, P.L. (ed.), *Prehistoric Barbados*:37-100. Archetype Publications Ltd., Wales

1991[b] The Barbados Archaeological Survey, 1985-1988. The Pottery. In: *Proceedings of the Thirteenth International Congress for Caribbean Archaeology*:524-540

Harris, M.H. and R. Hinds

1995 Pottery from Maxwell, Barbados. In: *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*:511-522.

Haviser, J.B.

1987[a] *An Archaeological excavation at the Cupecoy Bay site (SM-001), St. Maarten, Netherlands Antilles*. Reports of the Archaeological an Anthropological Institute of the Netherlands Antilles, Curaçao

1987[b] *Amerindian Cultural Geography on Curaçao*. Dissertation, Leiden University

1988 *An Archaeological Survey of St. Martin - St. Maarten*. Reports of the Institute of Archaeology and Anthropology of the Netherlands Antilles No. 7, Curaçao

1989 A Comparison of Amerindian Insular Adaptive Strategies on Curaçao. In: Siegel, P.E. (ed.), *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*:3-28. BAR International Series 506

1991 Prehistoric Cultural Developments on Bonaire, Netherlands Antilles. In: *Proceedings of the Fourteenth International Congress for Caribbean Archaeology*:237-261

1992 *Terms used in the Hope Estate Lithic Analysis Form*. Archaeological-Anthropological Institute of the Netherlands Antilles, Curaçao:1-16

Herrmann, B., G. Gruppe, S. Hummel, H. Piepenbrink, and H. Schutkowski

1990 *Prähistorische Anthropologie, Leitfaden der Feld-und Labormethoden*. Springer-Verlag, Berlin Heidelberg

Hinds, R. and M.H. Harris

1995 Pottery from Mustique. In: *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*:459-469

Hofman, C.L.

1993 *In Search of the Native Population of Pre-Columbian Saba (400-1450 A.D.), Part one: Pottery styles and their interpretations*. Dissertation, Leiden University

1995[a] *Three Late Prehistoric Sites in the Periphery of Guadeloupe: Grande Anse, Les Saintes, and Morne Cybèle 1 and 2, La Désirade*. Paper presented at the 16th International Congress for Caribbean Archaeology, Guadeloupe

1995[b] Terre-de-Bas, Grande Anse. In: *Bilan Scientifique de la Région Guadeloupe 1992-1994*. Publication de la Direction Régionale des Affaires Culturelles de Guadeloupe

in press. Hope Estate: Pottery. In: Hofman, C. and M.L.P. Hoogland (eds.), *Archaeological Investigations on St. Martin 1993, the sites of Norman Estate, Hope Estate, and Anse des Pères*. Publication by the Direction Régionale des Affaires Culturelles de Guadeloupe, Service Régional de l'Archéologie and Leiden University, Archaeological Centre

Hofman, C.L. and M.L.P. Hoogland

1994 *Rapport de Sondages 1994, Site de Morne Cybèle (Commune de La Désirade), No. 97110012*. Leiden

Hoogland, M.L.P.

1995 Sainte-Anne, Pointe Helleux. In: *Bilan Scientifique de la Région Guadeloupe 1992-1994*. Publication de la Direction Régionale des Affaires Culturelles de Guadeloupe

1996 *In Search of the Native Population of Pre-Columbian Saba (400-1450 A.D.), Part two: Settlement sites in their natural and social environment.* Dissertation, Leiden University

Humann. P.

1994 *Reef Fish Identification, Florida, Caribbean, Bahamas.* New World Publications, Florida

Humfrey, M.

1975 *Sea Shells of the West Indies, A Guide to the Marine Molluscs of the Caribbean.* New York

Jane, C.

1930 *The Voyages of Christopher Columbus, being the journals of his first and last voyages, to which is added the account of his second voyage written by Andres Bernaldez*:309-329. London

Jansen, R.

in press. Hope Estate: Shell. In: Hofman, C. and M.L.P. Hoogland (eds.), *Archaeological Investigations on St. Martin 1993, the sites of Norman Estate, Hope Estate, and Anse des Pères.* Publication by the Direction Régionale des Affaires Culturelles de Guadeloupe, Service Régional de l'Archéologie and Leiden University, Archaeological Centre

Jones, A.R.

1985 Dietary Change and Human Population at Indian Creek, Antigua. In: *American Antiquity* 50(3):518-536

Joyce, Th.A.

1973 *Central American and West Indian Archaeology*:233-241. New York

Keegan, W.F.

1982[a] Lucayan Fishing Practices: An Experimental Approach. In: *The Florida Anthropologist* vol. 35, No. 4:146-161

1982[b] A Biological Introduction to the Prehistoric Procurement of the *Strombus gigas.* In: *The Florida anthropologist*, Vol.35, No. 2:76-88.

1985 *Dynamic Horticulturalists: Population Expansion in the Prehistoric Bahamas.* Dissertation, University of California, Los Angeles

1986[a] The Optimal Foraging Analysis of Horicultural Production. In: *American Anthropologist* 88(1):92-107

1986[b] The Ecology of Lucayan Arawak Fishing Practices. In: *American Antiquity* vol. 51, No. 4:816-825

1987 *Evolutionary Ethnobiology: Behavioral Models of Foraging Efficiency and their Prehistoric Caribbean Correlates.* Paper presented at the 10th Ethnobiology Conference, Gainesville

1989[a] Transition from a Terrestrial to a Maritime Economy: A new view of the crab/shell dichotomy. In: Siegel, P.E. (ed.), *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean*:119-128

1989[b] Stable Isotope Analysis of Prehistoric Diet. In: Iscan, M.Y., and Kennedy, K.R. (eds.), *Reconstruction of Life from the Skeleton*:223-236. New York

1992[a] *The People who Discovered Columbus: the Prehistory of the Bahamas.* University Presses of Florida, Gainesville

1992[b] Lucayan Settlement Patterns and Recent Coastal Changes in the Bahamas. In: Johnson, L.L. (ed.), *Paleoshorelines and Prehistory: An Investigation of Method*:5-15. CRC Press, London

Keegan, W.F. and M.J DeNiro

1988 Stable Carbon-and Nitrogen-Isotope Ratios of Bone Collagen Used to Study Coral-reef and Terrestrial Components of Prehistoric Bahamian Diet. In: *American Antiquity* 53(2):320-336

Keegan, W.F., A. Johnson, and T. Earle

1985 Carrying Capacity and Population Regulation: A Comment on Dewar. In: *American Anthropologist* 87(3):659-663

Khudabux, M.R., G.J.R Maat, and A.H Versteeg

1987 The Remains of Prehistoric Amerindians of the "Tingi Holo Ridge" in Suriname: A Fysical Anthropological Investigation of the "Versteeg Collection". In: *Proceedings of the Twelfth International Congress of Caribbean Archaeology, Cayenne, French Guiana*:135-151

Kirby, E.I.A.

1974 The Cayo pottery of St. Vincent: a Pre-Caliviny series. In: *Proceedings of the Fifth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:61-64

1976 The Pre-Hispanic Peopling of the Antilles. In: *Proceedings of the Sixth International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:14-20

Klift, van der, H.M.

1992 Faunal Remains of Golden Rock. In: Versteeg, A.H. and K. Schinkel, *The Archaeology of St. Eustatius, The Golden Rock Site*:74-83. Publication of the St. Eustatius Historical Foundation, no.2; Publication of the Foundation for Scientific Research in the Caribbean Region, no.131. Tilburg

Klinken, van, G.J.

1991 Dating and dietary reconstruction by isotopic analysis of amino acids in fossil bone collagen - with special reference to the Caribbean. In: *Publications of the Foundation for Scientific Research in the Caribbean Region* 128. Amsterdam

Knippenberg, S.

1995 *Norman Estate and Anse des Pères, Two Pre-Columbian Sites on Saint Martin, survey and lithics*. Master thesis, Leiden University

Lasserre, G.

1961[a] *La Guadeloupe, Etude géographique. Tome 1, Le Milieu Naturel, l'Héritage du Passé*:143-258. Bordeaux

1961[b] *La Guadeloupe, Etude géographique. Tome 2, Les Régions Géographiques, Les Problèmes Guadeloupéens*:767-806,883-917, Bordeaux

Lieske. E. and R.F. Myers

1995 *Guide des Poissons de Récifs Coralliens. Région Caraïbe, océan Indien, océan Pacifique, mer Rouge*. Adaptation française par Y. Bouchon-Navaro. Delachaux et Niestlé, Paris

Maat, G.J.R and L. Smits

1992 The Physical-Anthropological Remains from Golden Rock. In: Versteeg, A.H. and K. Schinkel, *The Archaeology of St.Eustatius, The Golden Rock Site*:237-247. Publication of the St.Eustatius Historical Foundation, no.2; Publication of the Foundation for Scientific Research in the Caribbean Region, no.131. Tilburg

Mattioni, M. and R.P. Bullen

1970 A Chronological Chart for the Lesser Antilles. In: *Proceedings of the Third International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:1-3

McKusick, M.

1960 *The distribution of ceramic styles in the Lesser Antilles*. Dissertation, Yale University, New Haven

Merwe, van der, N.J, A.C. Roosevelt and J.C. Vogel

1981 Isotopic evidence for prehistoric subsistence change at Parmana, Venezuela. In: *Nature* 292:536-538

Milliman, J.D.

1973 Caribbean Coral Reefs. In: Jones, O.A., and R. Endean (eds.), *Biology and Geology of Coral Reefs*, Volume 1, geology 1:1-50. Academic Press, New York

Mitchell, R.C.

1953 New Data regarding the Dioritic Rocks of the West Indies. In: Brouwer, A. (ed.), *Geologie en Mijnbouw (nieuwe serie)*:285-295. s' Gravenhage

Newsom, L.A.

1993 *Native West Indian Plant Use*. Dissertation, University of Florida

Nicholson, D.V.

1975 *A Possible Historic Indian Site on Petite Terre, Guadeloupe*. Antigua Archaeological Society, Antigua

1976 Artifact types of Preceramic Antigua. In: *Proceedings of the Sixth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*: 264-271

Nokkert, M.

1995 *Prehistoric Faunal Exploitation on St. Martin. An Analysis of Vertebrate Faunal Material from the Pre-Ceramic Norman Estate and the Cedrosan Saladoid Anse des Pères sites*. Master Thesis, Leiden University

Petit, V.

1989 *Evaluation du potentiel en souterraine de l'île de Désirade*. Pointe-à-Pitre

Petitjean-Roget, H.

1983 *Compte Rendu de Mission à La Désirade au Sujet de la Destruction Accidentelle d'un Site Archéologique au lieu dit Petite Rivière, Ile de La Désirade, Guadeloupe*. Pointe-à-Pitre

Powell, M.L.

1985 The Analysis of Dental Wear and Caries for Dietary Reconstruction. In: Gilbert, R.I., and J.H. Mielke, *The Analysis of Prehistoric Diets*:307-338. Academic Press, Orlando

Puis, du, F.M.

1632 *Relation de l'establissement d'une colonie françoise dans la Gardeloupe, isle de l'Amérique, et des moeurs des sauvages*

Rainy, F.

1941 *Excavations in the Ft. Liberte Region, Haiti*. Yale University Publications in Anthropology, No.23, New Haven

Reitz, E.J.

1994 Archaeology of Trants, Montserrat. Part 2. Vertebrate Fauna. *Annals of the Carnegie Museum*, 63(4):297-317

Renfrew, C and P. Bahn

1991 *Archaeology. Theories, Methods and Practice*. London

Reuer, E. and S. Reuer-Fabrizii

1986 Erster anthropologischer Bericht über die Skelettfunde von Pointe de Caille, St. Lucia, West Indies. In: Friesinger et al., 1986, *Grabungen und Forschungen auf St. Lucia, 1984*:33-36. Mitteilungen der prähistorischen Kommision der Osterreichischen Akademie der Wissenschaften. Vienna

Rice, P.

1987 *Pottery Analysis: a sourcebook*. University of Chicago Press, Chicago

Rochefort, de, C.

1658 *Histoire Naturelle et Moralle des Isles Antilles de l'Amérique*. Arnold Lucas, Rotterdam

Roos, P.J.

1971 The Shallow-Water Stony Corals of the Netherlands Antilles. In: *Studies on the Fauna of Curaçao and other Caribbean Islands*, Vol. 37, no. 130:1-108

Roosevelt, A.C.

1980 *Parmana: Prehistoric Maize and Manioc Subsistence along the Amazon and Orinoco*. Academic Press, New York

1987 The Evolution of Human Subsistence. In: Harris, M. and E.B. Ross (eds.), *Food and Evolution, Towards a Theory of Human Food Habits*:565-578. Philadelphia

Ross, E.B.

1978 Food Taboos, Diet, and Hunting Strategy: The Adaptation to Animals in Amazon Cultural Ecology. In: *Current Anthropology* 19(1):1-36

Rouse, I.

1952 *Porto Rican Prehistory*. The New York Academy of Sciences, Scientific Survey of Porto Rico and the Virgin Islands, vol. 18, parts 3,4. New York

1964 Prehistory of the West Indies. In: *Science*, 144: 499-513. Lancaster

1976 The Saladoid sequence on Antigua and its aftermath. In: *Proceedings of the Sixth International Congress for the study of Pre-Columbian Cultures of the Lesser Antilles*:35-41

1977 Pattern and Processes in West Indian Archaeology. In: *World Archaeology* 9(1): 1-11

1986 *Migrations in Prehistory. Inferring Population Movement from Cultural Remains.* Yale University Press, New Haven

1989 Peoples and Cultures of the Saladoid Frontier in the Greater Antilles. In: Siegel, P. (ed.), *Early Ceramic Population and Lifeways and Adaptive Strategies in the Caribbean*:383-403. BAR International Series 506, Oxford

1992 *The Tainos. Rise and Decline of the People who greeted Columbus.* Yale University Press, New Haven

Rouse, I. and R.E. Alegría

1990 *Excavations at María de la Cruz Cave and Hacienda Grande Village site, Loiza, Puerto Rico.* Yale University Publications in Anthropology, 80. New Haven

Rouse, I. and L. Allaire

1978 Caribbean. In: Taylor, R.E., and C.W. Meighan (eds.), *Chronologies of New World Archaeology*:411-481. Academic Press, New York

Rouse, I., B. Faber Morse and D. Nicholson

1995 Excavations at Freeman's Bay, Antigua. In: *Proceedings of the fifteenth International Congress for Caribbean Archaeology*:445-460

Schiffer, M.B.

1987 *Formation Processes of the Archaeological Record.* University of New Mexico Press, Albuquerque

Sealey, N.

1992 *Caribbean World, A Complete Geography.* Cambridge

Shepard, A.O.

1963 *Ceramics for the Archaeologist.* Fourth printing. Washington D.C.

Siegel, P.E. (ed.)

1989 *Early Ceramic Population Lifeways and Adaptive Strategies in the Caribbean.* Oxford

1991 Saladoid survival strategies: evidence from site locations. In: *Proceedings of the Fourteenth International Congress for Caribbean Archaeology*:315-337

1992 *Ideology, power and social complexity in Prehistoric Puerto Rico.* 2 vols. Dissertation, State University of New York. Binghamton

Sipe, S.E., J.P.Collins, A.E. Dittert jr., and R.C. Goodwin

1980 The Preservation and Study of Prehistoric Coral and Coral Artefacts. In: *Proceedings for the Eight International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:246-263

Smith, E.A.

1983 Anthropological Applications of Optimal Foraging Theory: A Critical Review. In: *Current Anthropology* 24(5):625-651

Steen, van der, E.J.

1992 Shell artefacts of Golden Rock. In: Versteeg, A.H. and K. Schinkel, *The Archaeology of St. Eustatius: The Golden Rock Site*:93-118. Publication of the St.Eustatius Historical Foundation, no.2; Publication of the Foundation for Scientific Research in the Caribbean Region, no.131. Tilburg

Steenvoorden, R.I.

1992 Golden Rock Coral. In: Versteeg, A.H. and K. Schinkel, *The Archaeology of St. Eustatius: The Golden Rock Site*:119-139. Publication of the St.Eustatius Historical Foundation, no.2; Publication of the Foundation for Scientific Research in the Caribbean Region, no.131. Tilburg

Steward, J.H.

1955 *Theory of Culture Change, the Methodology of Multilinear Evolution*. University of Illinois Press, Urbana

Stokes, A.

1995 Understanding Prehistoric Subsistence in the West Indies Using Stable Isotope Analysis. In: *Proceedings of the Fifteenth International Congress for Caribbean Archaeology*:191-200

Sullivan, S. D.

1981 *Prehistoric Patterns of Exploitation and Colonization in the Turks and Caicos Islands*. University of Illinois at Urbana-Champaigne, University Microfilms International, Ann Arbor

Sutty, L.

1976 Archaeological Excavations at Miss Pierre, Union Island, the Grenadines. In: *Proceedings of the Sixth International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:66-75.

1978 A Study of Shells and Shelled Objects from six pre-Columbian Sites in the Grenadines of St. Vincent and Grenada. In: *Proceedings for the Seventh International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:195-210

1985 A Listing of Amerindian Settlements on the Island of Carriacou in the Southern Grenadines and a report on the Most Important of These. In: *Proceedings of the Eleventh International Congress for Caribbean Archaeology*:242-259

1987 A Preliminary Inventory and Short Essay on Ceramic and Stone Artifacts From Recent Excavations on Grenada and in the Southern Grenadines. In: *Proceedings of the Twelfth International Congress of Caribbean Archaeology, Cayenne, French Guiana*:73-85

Tacoma, J.

1985 Skeletal Remains from de Savaan Region, Curaçao. In: *Proceedings of the Eleventh International Congress for Caribbean Archaeology*:217-223

Taverne, Y. and A.H. Versteeg

1992 Golden Rock Shells. In: Versteeg, A.H. and K. Schinkel, *The Archaeology of St. Eustatius: The Golden Rock Site*:84-92. Publication of the St.Eustatius Historical Foundation, no.2; Publication of the Foundation for Scientific Research in the Caribbean Region, no.131. Tilburg

Tertre, du, Le R.P.

1667 *Histoire Générale des Antilles habitées par les François*. Paris (Facsimile edition 1973, Fort-de-France, Editions des Horizons Caraïbes)

Uchupi, E.

1975 Physiography of the Gulf of Mexico and the Caribbean Sea. In: Nairn, A.E.M., and F.G. Stehli (eds.), *The Ocean Basins and Margins. Volume 3. The Gulf of Mexico and the Caribbean*. New York

Versteeg, A.H. and K. Schinkel

1992 *The Archaeology of St. Eustatius: The Golden Rock Site*. Publication of the St.Eustatius Historical Foundation, no.2; Publication of the Foundation for Scientific Research in the Caribbean Region, no.131. Tilburg

Vescelius, G.

1980 A Cultural Taxonomy for West Indian Archaeology. In: *Journal of the Virgin Islands Archaeological Society* 10:36-39

Vita-Finzi, C. and E.S. Higgs

1970 Prehistoric economy in the Mount Carmel area of Palestine: Site Catchment analysis. In: *Proceedings of the Prehistoric Society* 36:1-37

Waal, de, M.S.

in press. Hope Estate: stone tools. In: Hofman, C. and M.L.P. Hoogland (eds.), *Archaeological Investigations on St. Martin 1993, the sites of Norman Estate, Hope Estate, and Anse des Pères*. Publication by the Direction Régionale des Affaires Culturelles de Guadeloupe, Service Régional de l'Archéologie and Leiden University, Archaeological Centre

Walker, J.B.

1980 Analysis and Replication of Lithic Artifacts from the Sugar Factory Pier Site, St. Kitts. In: *Proceedings of the Eight International Congress for the Study of Pre-Columbian Culture in the Lesser Antilles*:69-79

1985 A Preliminary Report on the Lithic and Osteological Remains from the 1980, 1981 and 1982 Field Seasons at Hacienda Grande (12 PS07-5). In: *Proceedings of the Tenth International Congress for the Study of the Pre-Columbian Cultures in the Lesser Antilles*:181-224

Westercamp, D.

1978 *Carte Géologique de la Désirade (1:25000), et Notice Explicative*. Service Géologique Régional des Antilles et de la Guyane, Fort-de-France

Westercamp, D. and H. Tazieff

1980 *Guides géologiques régionaux: Martinique, Guadeloupe, Saint-Martin, La Désirade*:87-128. Paris

Weyl, R.

1966 Die Kalkantillen. In: *Geologie der Antillen, Beiträge zur regionalen Geologie der Erde*, Band 4:240-263. Berlin

Willey G.R. and J.A. Sabloff

1980 *A History of American Archaeology*. Second edition, London

Wing, E.S.

1968 Aboriginal Fishing in the Windward Islands. In: *Proceedings of the Second International Congress for the Study of the Pre-Columbian Cultures of the Lesser Antilles*:103-107

1989 Human exploitation of animal resources in the Caribbean. In: Woods, C.A. (ed.), *Biogeography of the West Indies: Past, Present, and Future*:137-152. Sandhill Crane Press, Gainesville, Florida

1990 Animal remains from the Hacienda Grande site. In: Rouse, I. and R.E Alegria, *Excavations at the Maria de la Cruz Cave and Hacienda Grande Village Site, Loiza, Puerto Rico*:87-101. Yale University Publications in Anthropology No.80, New Haven

1991[a] Animal Exploitation in Prehistoric Barbados. In: *Proceedings of the fourteenth International Congress for Caribbean Archaeology*:360-367

1991[b] Economy and Subsistence: Faunal remains. In: Drewett, P.L. (ed.), *Prehistoric Barbados*:134-152. Archetype Publications Ltd., Wales

1995 Rice Rats and Saladoid People as Seen at Hope Estate. In: *Proceedings of the fifteenth International Congress for Caribbean Archaeology*:219-231

1996 Appendix 2: Vertebrate Remains from the Sites of Spring Bay and Kelbey's Ridge, Saba, Netherlands West Indies. In: Hoogland, M.L.P., 1996, *In Search of the Native Population of Pre-Columbian Saba (400-1450 A.D.), Part two: Settlement sites in their natural and social environment.* Dissertation, Leiden University

Wing, E.S. and A.B. Brown

1979 *Paleonutrition: Method and Theory in Prehistoric Foodways.* Academic Press, New York

Wing, E.S. and E.J. Reitz

1982 Prehistoric Fishing Economies of the Caribbean. In: *Journal of New World Archaeology* 5(2):13-32

Wing, E.S. and S.J. Scudder

1980 Use of animals by the prehistoric inhabitants on St. Kitts, West Indies. In: *Proceedings of the Eight International Congress for the Study of Pre-Columbian Cultures of the Lesser Antilles*:237-245

1983 Animal exploitation by prehistoric people living on a tropical marine edge. In: Grigson, C., and J. Clutton-Brock, *Animals and Archaeology: 2. Shell Middens, Fishes and Birds*:197-210. BAR International Series 183, Oxford

Yesner, D.R.

1987 Life in the "Garden of Eden". Causes and Consequences of the Adaption of Marine Diets by Human Societies. In: Harris, M. and E.B. Ross (eds.), *Food and Evolution, Toward a Theory of Human Food Habits*:285-310. Philadelphia

Zubrow, E.B.W.

1975 *Prehistoric Carrying Capacity: A Model.* California